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T. O. No. 16-35TS147-11

HANDBOOK
OPERATION AND SERVICE INSTRUCTIONS
WITH PARTS LIST

TEST SET
TS-147A/UP

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

CENTRAL PRESS, INC., MARION, INDIANA
2300—ORIGINAL—5-12-52

26 MARCH 1952

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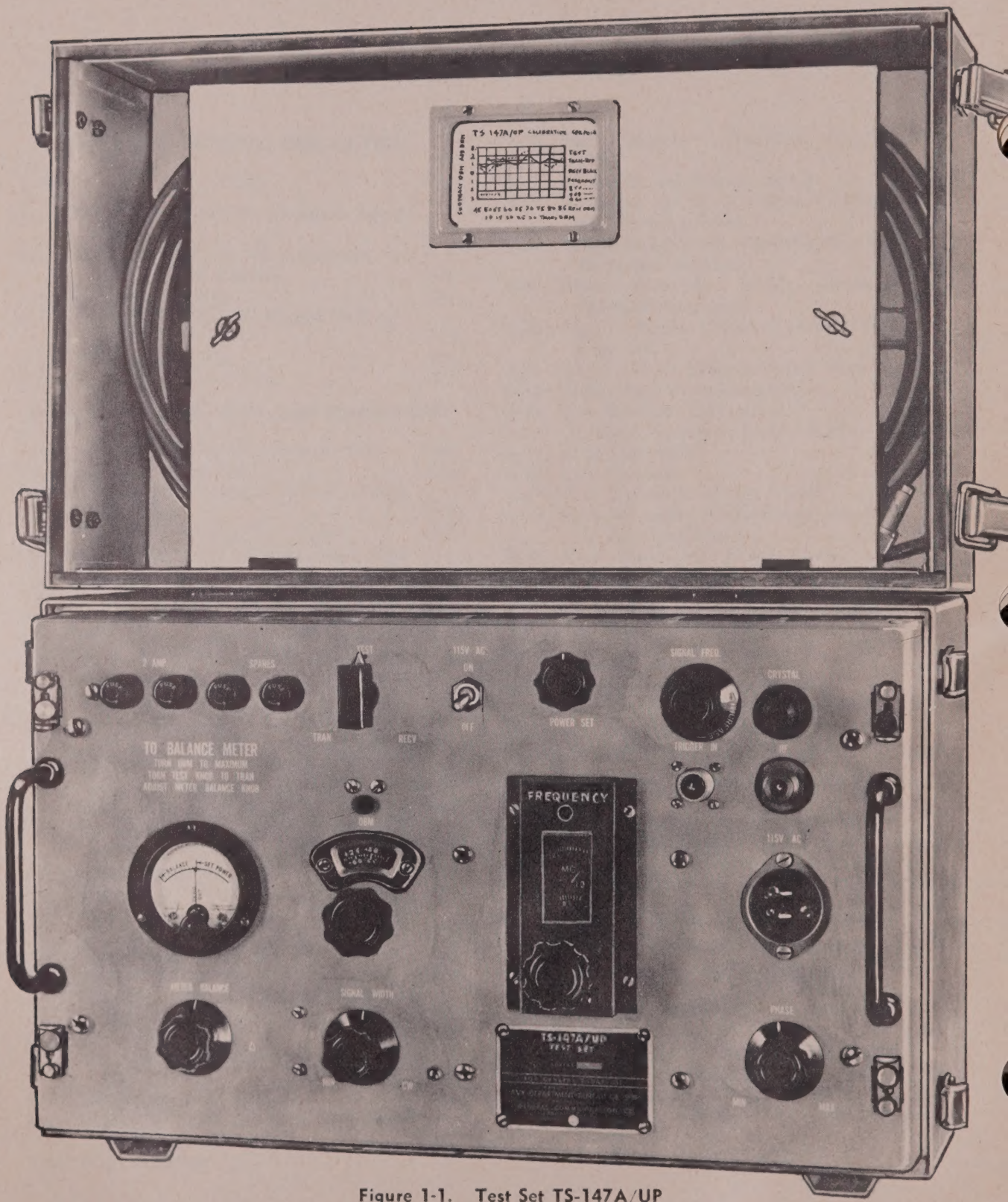


Figure 1-1. Test Set TS-147A/UP
Complete Equipment

SECTION I
GENERAL DESCRIPTION

1. GENERAL INFORMATION.

a. Test Set TS-147A/UP (figure 1-1) is a portable microwave signal generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency band of 8500 Mc to 9600 Mc.

b. The test set supplies microwave test signals (either f-m or c-w) of known power level and frequency. These signals, together with the aid of an oscilloscope (A-type scan) for observing the radar video output, can be used in visual alignment methods in testing and adjusting radar systems. The sweep of the test signal frequency modulation and the horizontal sweep of the oscilloscope are triggered in synchronism with the radar system firing cycle. Because this timing makes the horizontal A-scope sweep proportional to the frequency of the f-m test signals, the resulting patterns seen on the A-scope represent the frequency response curve of the receiver section of the radar system. The oscilloscope patterns show the effect of system adjustments.

c. The test set contains a direct reading frequency meter and a power level meter which measures power referenced to one milliwatt. These functions can be used for measuring either input or output power levels and frequencies of the same without any auxiliary equipment.

d. This publication is issued as a basic handbook of operating and maintenance instructions. The instructions describe procedures for operation, application, and maintenance of the test set. A section which describes the basic principles and theory of operation is included for the information and guidance of operating personnel.

2. EQUIPMENT SUPPLIED.

a. The following table shows the equipment supplied. The complete equipment is shown in figure 1-1.

Quan. Per Equipment	*Name of Unit*	*Army-Navy Type Designation*	*Dimensions*			*Weight (Pounds)*
			Width	*Length*	*Height*	
1	TEST SET (complete)	TS-147A/UP	11 in.	18¾ in.	12¼ in.	35
1	*Pick-up Antenna	AT-68/UP	2¼ in.	6¾ in.	4½ in.	0.14
1	*Cord	CG-92B/U (8)	—	8 ft.	—	1.25
1	*Cord	CG-91/U (6)	—	6 ft.†	—	1.25
1	†Coaxial Cable Fitting	Navy-49192	—	—	—	—
1	*CORD Assembly, Power	CX-337/U (6)	—	6 ft.	—	0.13
1 set	*SPARES, Operating (described in par. 4.f.)	————	—	—	—	—

* Items packed in cover of test set carrying case.

† Attached to Trigger Cable CG-91/U (6).

3. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

a. The following equipment must be used with the test set in most of the applications to testing radar systems: Oscilloscope TS-34/AP series (or equivalent) for receiver tests. a directional coupler for quantitative measurements.

Quan. Per Equipment	*Name of Unit*	*Army-Navy Type Designation*	*Required Characteristics*
1	Oscilloscope[1]	TS-34/AP series, or equivalent	Start-stop type sawtooth sweep triggered at radar recurrence frequency to produce A-scan. (Portable type.)
1	Oscilloscope[1]	TS-239/UP series, or equivalent	Same as above. (Bench type.)

[1]Either oscilloscope can be used.

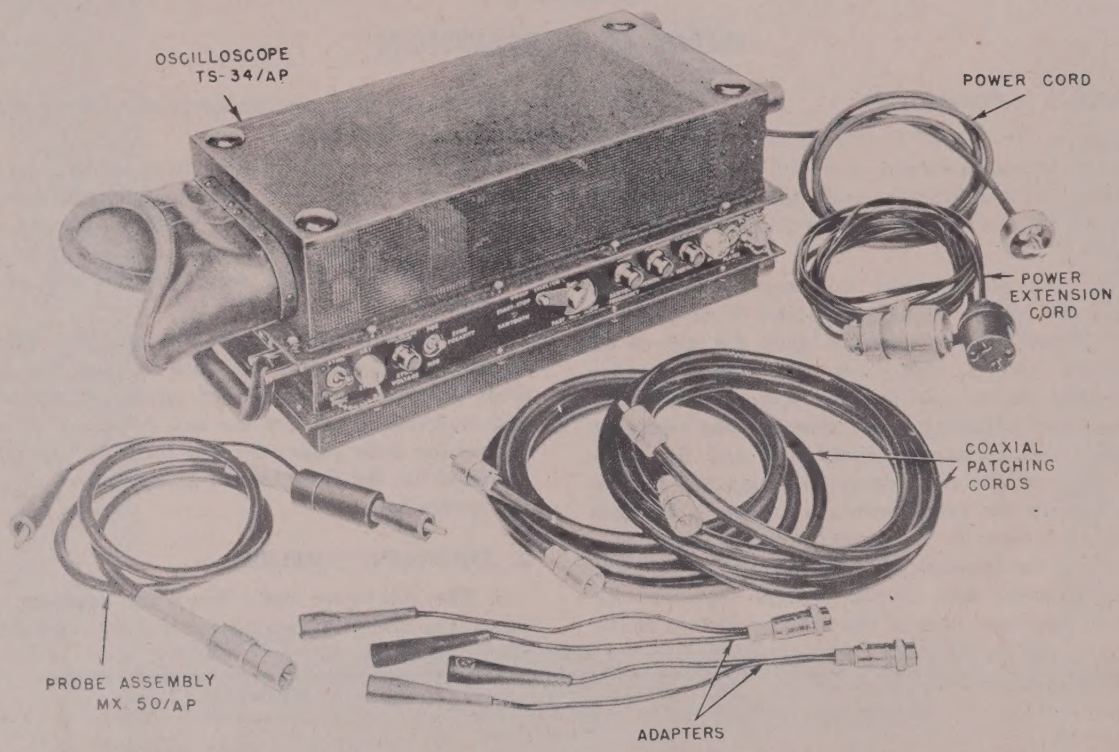


Figure 1-2. Oscilloscope TS-34/AP
Equipment Required but Not Supplied

4. PHYSICAL DESCRIPTION.

a. TEST SET TS-147A/UP (figure 1-4).—The test set is completely enclosed on five sides by a removable dust cover and on the front by the control panel. The control panel is fitted with a protective cover which contains all the cables and accessories listed in paragraph 2. All controls, indicators, and cable connections are located on the front panel.

b. PICK-UP ANTENNA AT-68/UP (figure 1-5).—The pick-up horn is a small directive antenna assembly which can be used both for receiving external r-f energy to be measured by the test set and for transmitting the r-f test signal generated in the test set. The horn consists of a tapered section of wave guide which is terminated by a probe coupling to a coaxial fitting. The horn is connected to the RF receptacle on the test panel by means of the r-f cable assembly CG-92B/U(8).

c. R-F CORD ASSEMBLY CG-92B/U(8) (figure 1-5).—This cable is used for making the r-f connection to the radar system under test. Either a directional coupler or a pick-up horn is used to complete the r-f connection. The cable assembly consists of eight feet of RG-9A/U cable fitted with two UG-21B/U connectors. Connection is made to the UG-23/U receptacle marked "RF" on the control panel. (See figures 2-2 and 2-3.) The attenuation of the cable may change with time.

d. TRIGGER CORD ASSEMBLY CG-91/U(6) (figure 1-5).—This cable is used for connecting a trigger voltage to the test set when it is not possible to trigger the set by means of r-f pulses. The cable assembly consists of six feet of RG-11/U cable fitted with two Navy type 49195 connectors. One of the 49195 connectors is replaced by a Navy 49192 right angle connector. The trigger cable connects to the receptacle marked "TRIGGER" on the control panel.

e. POWER CORD ASSEMBLY CX-337/U(6) (figure 1-5).—Connection of the test set to a 115-volt, a-c power source is made by this cable. The assembly consists of six feet of rubber covered two-conductor

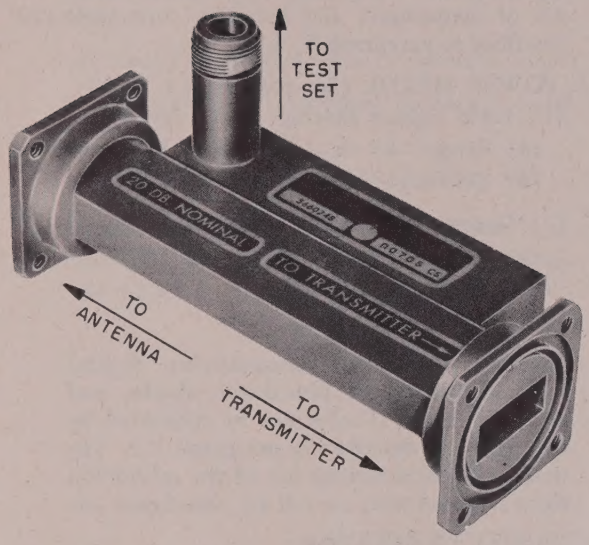


Figure 1-3. Directional Coupler

cord fitted with a female and a male plug. The female plug connects to the receptacle marked "115V AC" on the control panel. The male plug will fit a standard two-prong wall-type receptacle.

f. OPERATING SPARES (figures 1-5 and 4-4).—The following operating spares are supplied to replace corresponding parts in the test set:

(1) THERMISTOR MOUNT MX-435/UP.—One calibrated thermistor mount, complete with bead and disc thermistors. This spare is bolted inside the test set chassis. (See figure 4-4.)

(2) FUSES.—Five two-ampere type 3AG cartridge fuses, two of which are mounted in the holders marked "SPARES" on the control panel.

(3) GASKETS.—Nine gaskets used in wave guide flange joints. (See figure 3-4.)

(4) LAMPS.—Three 3.0-volt panel lamps.

(5) CRYSTALS.—Two Navy type 1N23A silicon rectifier crystals to replace the crystal in the r-f output and detector section.

5. ELECTRICAL DESCRIPTION.

a. Test Set TS-147A/UP is a microwave signal generator which supplies frequency-modulated and c-w test signals, and measures power and frequency.

b. The signal generator consists essentially of a reflex klystron oscillator (2K25) and a triggered sweep generator which can modulate the frequency of the klystron by applying a sawtooth voltage to the reflector of the tube. The sweep can be triggered either by r-f pulses applied to the RF receptacle or by voltage pulses applied to the TRIGGER receptacle of the test set.

c. Frequency modulated pulses are produced by an internal sawtooth sweep which can be varied to produce frequency excursions from zero (cw) to at least 60 Mc by changing the sweep amplitude. At maximum amplitude the sweep voltage covers three modes of the klystron. On the A-scope each mode covered appears as a sharp pip. The pips can be widened into broad response curves by decreasing the sweep amplitude. Changing the d-c level of the sweep changes the position of the test signals along the range axis of the A-scope. Test signals can be seen on all types of radar indicators as artificial signals.

d. Average power measurements are made by a temperature compensated thermistor-bridge wattmeter and a calibrated r-f attenuator. The test set can measure both the power level of the test signals generated internally and the power level of external signals applied to the test set. Power is measured in dbm (decibels relative to one milliwatt) over a range of —42 to —83 dbm for peak levels of test signals supplied by the set and +7 to +30 for average levels of external power applied to the test set. These measurements are accurate within 2.0 db. The ranges stated give the levels at the RF input-output connection on the test set and in use, the attenuation of cables and coupling devices must be added to these levels.

e. Frequency measurements are made by an absorption frequency meter which uses the thermistor bridge wattmeter as a tuning indicator. When tuned to resonance the frequency meter reflects part of the power so that a dip in the wattmeter indication is observed.

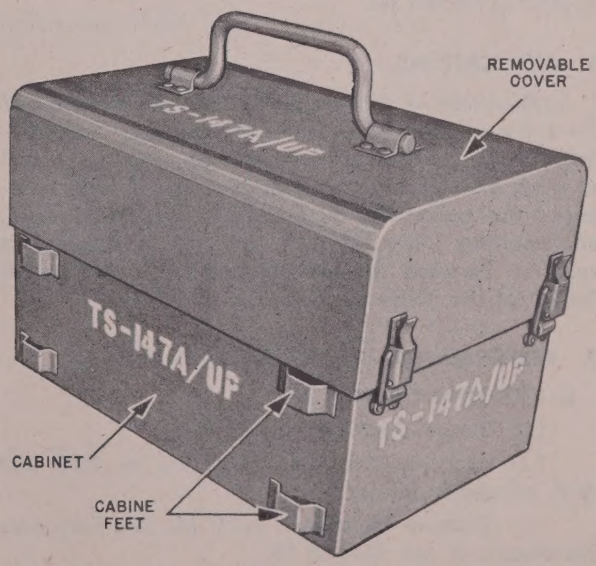


Figure 1-4. Test Set TS-147A/UP Stowed for Carrying

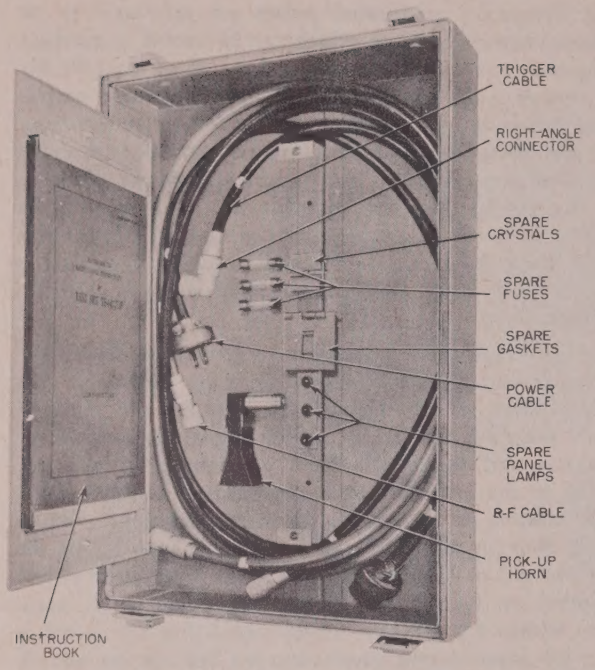


Figure 1-5. Test Set Accessories

The range of the frequency meter is 8500 to 9600 Mc. It is accurate to within 2.5 Mc over this range. The frequency difference between any two signals not more than 60 Mc apart can be measured to within 1.0 Mc. The frequency meter is calibrated to within 1.0 Mc at 9310 Mc. The frequency meter can be used both for test signals generated in the test set and external power applied to the test set.

6. APPLICATIONS.

Applications of the test set include measurement of the radar transmitter power and frequency; measurement of the radar receiver bandwidth, sensitivity, and recovery time; tuning of radar and beacon local oscillators; and performance tests of TR box, AFC system, and rotating joints. Usually only one connection is required between the test set and the radar system for all of the above applications.

7. PERFORMANCE CHARACTERISTICS.

a. FREQUENCY METER.

(1) Range: 8500 Mc to 9600 Mc.

(2) Absolute Accuracy: ±2.5 Mc at 25°C and 60% relative humidity.

(3) Relative Accuracy: ±1.0 Mc for frequency increments of less than 60 Mc.

(4) Calibration Point: 9310 ±1.0 Mc at 25°C and 60% relative humidity.

Note

Accuracy can be greatly improved through use of temperature and humidity corrections described in paragraph V. 6.

b. POWER METER. (See paragraph I. 5. *d.*)

(1) Input Signals (average power levels).

(*a*) Range: +7 to +30 dbm at RF receptacle.

(*b*) Accuracy: ±2.0 db.

(2) Output Test Signals (peak mode power).

(*a*) Range: —42 to —83 dbm at RF receptacle.

(*b*) Accuracy: ±2.0 db.

Note

Accuracy of power measurements depend upon calibration of directional coupler and r-f cable losses. Cables can be calibrated by the procedure described in paragraph V.2. The stated tolerances assume use of the calibration chart supplied with the test set. See figure 1-6.

c. SIGNAL GENERATOR.

(1) Tuning Range: 8500 Mc to 9600 Mc, provided a suitable oscillator tube is available.

(2) Power Output: As specified in 7. *b.* (2) (*a*).

(3) Frequency Modulation.

(*a*) Sweep Rate: Zero to 6 Mc/μs for oscillator tubes having at least 3 Mc/volt tuning range.

(*b*) Center Frequency Range: As specified in 7. *c.* (1).

(*c*) Phase Range: 3 to 50μs after trigger.

(*d*) Frequency Excursion of Sweep: Zero to over 60 Mc.

(*e*) With suitable oscillator tubes, the reflector voltage sweep can cover three modes.

(*f*) Triggers Required for Sawtooth Sweep Generator.

1. R-f Trigger: 5 to 500 watts peak, 0.5 to 6 μs duration, time of rise less than 0.5μs.

2. Video Trigger: Positive polarity, 10 to 50 volts peak, 0.5 to 20μs duration at 10% max. amplitude, less than 0.5μs time of rise between 90% and 10% max. amplitude points.

d. POWER REQUIREMENTS.

(1) Voltage: 115 volts ±10%.

(2) Frequency: 50 to 1600 cycles.

(3) Power: Approx. 125 watts.

e. POWER SUPPLY VOLTAGES.

(1) Plate Supply: +300 volts, electronic regulated.

(2) Reflector Supply: —210 volts, gas-tube regulated.

(3) Ripple: less than 0.1% peak of d-c level.

f. SAWTOOTH SWEEP.

(1) Amplitude: 0 to —100 volts (negative polarity).

(2) Slope: 0 to +2.0 volts/μs (positive slope).

(3) D-c Level at Oscillator Reflector: —60 to —210 volts.

(4) Trigger Amplifier Gain: Approx. 500.

g. TUBE AND CRYSTAL COMPLEMENT.

2—OC3/VR-105	V-R tube (V105, V106)
1—1N23	Silicon rectifier crystal (Y101)
1—5R4-GY	Full-wave rectifier (V101)
2—6SL7-GT	Twin triode (V107, V108)
1—6SH7	Pentode regulator amplifier (V103)
1—6Y6-G	Beam power regulator control (V102)
1—723A/B or 2K25	Microwave oscillator (V104)

h. Test Set TS-147A/UP is identical to Test Set TS-147/UP with the exception of a newly-designed oscillator housing, changes in the arrangement of components in the chassis, etc.

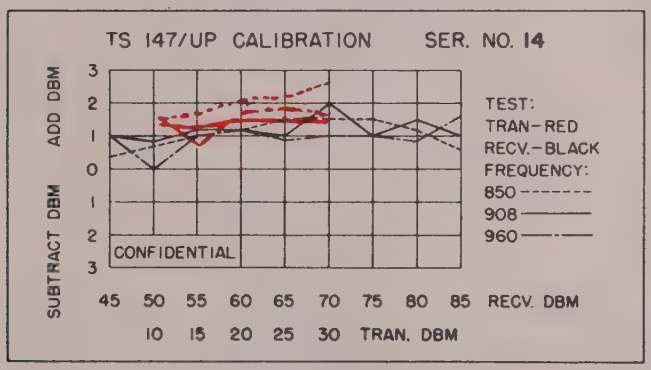


Figure 1-6. Typical Calibration Chart

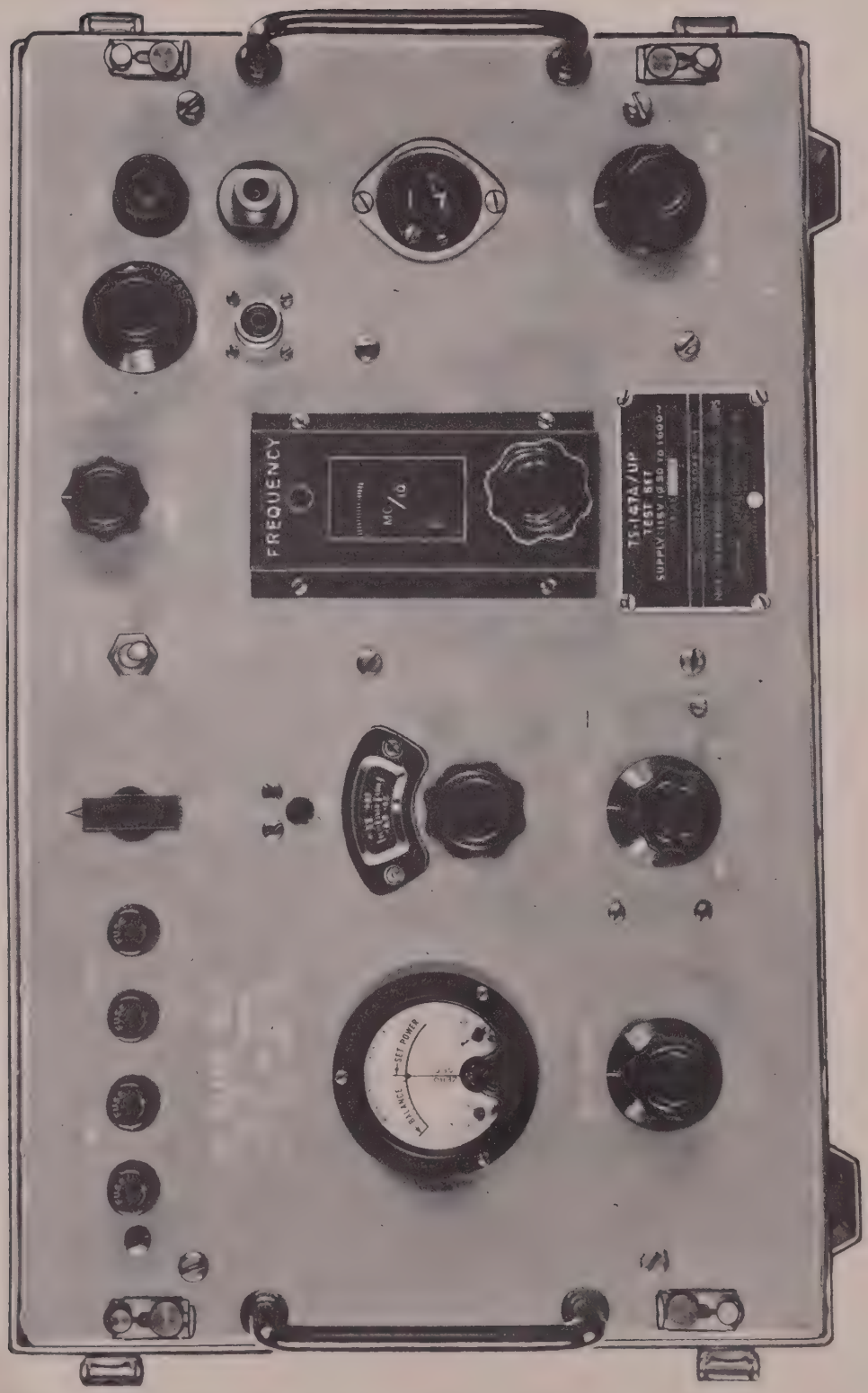


Figure 2-1. Test Set TS-147A/UP
Control Panel

SECTION II
OPERATION AND ADJUSTMENT

1. GENERAL.

This section describes the installation, operation, and application of Test Set TS-147A/UP. The material under APPLICATIONS illustrates specific uses of the test set in testing various radar systems. For detailed explanation of the principles of operation, see section III.

2. INSTALLATION AND ADJUSTMENT.

a. Test Set TS-147A/UP is a portable instrument which requires no installation or special adjustments before it is connected to a power supply and put into operation. The only requirements for best operation of the test set are:

(1) When making connections the operator should arrange the equipment so that it is possible to operate the test set controls and observe the patterns on the oscilloscope screen while making adjustments on the radar system.

(2) The power source must be able to furnish at least 125 watts of power at 115v ±10%, 50 to 1600 cycles.

CAUTION

SET THE DBM ATTENUATOR TO MAXIMUM ATTENUATION BEFORE CONNECTING THE POWER CORD AND TURNING ON THE TEST SET.

b. Refer to figure 7-5 for outline dimensions and to figure 7-4 for cable information.

3. PERFORMANCE TEST.

When necessary, the following performance check can be used to ascertain whether or not the equipment is in operating condition before being issued to operating personnel:

a. Take off cover of test set and remove chassis from case. The chassis is retained in the case by the four snap-slide fasteners on the control panel, indicated by A in figures 4-1, 4-2, and 4-3.

b. Inspect the test set chassis for damaged tubes and components. Make certain that no tubes are missing and that all tubes are placed completely in their proper sockets.

c. Turn the SIGNAL FREQ shaft to see that the coupling end turns the tuning nut on the oscillator tube.

d. Examine the bridge meter for damage. If the meter needle stands deflected from the ZERO SET line, adjust the zero set screw until the deflection is reduced to zero.

e. Connect the test set to a 115v (50 to 1600 cycle) power source.

f. Turn ON-OFF switch to ON and allow approximately one or two minutes for the test set to warm up.

g. During warm-up time the dial lamps for the DBM and FREQUENCY dials should light. Also tubes V105 and V106 (figure 4-1) should glow steadily and the needle of the bridge meter should deflect from the SET POWER point.

h. After warm-up is complete, turn the TEST knob to TRAN and adjust the METER BALANCE knob until the meter reads BALANCE. If this adjustment cannot be made properly, then adjust the METER ADJUST potentiometer according to the instructions in paragraph IV. 5.

i. Make the following control settings:

Control	*Setting*
SIGNAL WIDTH	Full clockwise (CW)
PHASE	Full counterclockwise (MIN)
TEST	RECV
POWER SET	Full counterclockwise
SIGNAL FREQ	Middle of range

j. Turn the PHASE control slowly clockwise until the meter needle deflects to the right from the BALANCE point. This indicates that the oscillator tube is oscillating. Adjust the PHASE control for maximum deflection, then turn the POWER SET knob clockwise to limit the deflection to the SET POWER point.

k. Continue to turn the PHASE control *slowly* clockwise until the needle drops back to BALANCE position and then deflects again towards SET POWER. There should be at least three separate positions of the PHASE control where the meter needle deflects to indicate oscillation.

l. Adjust the PHASE control for the peak of the largest of the several deflections. Adjust the POWER SET knob to set the meter needle to the highest on-scale reading that is practical to use. Turn the FREQUENCY knob fully counterclockwise.

m. Very slowly turn the FREQUENCY knob clockwise until a dip is produced in the meter deflec-

tion. Adjustment of FREQUENCY knob to obtain this dip is very sharp and must be performed carefully in order to locate it.

n. If the test set passes the above tests satisfactorily, replace the chassis into the case and re-lock the four snap-slide fasteners.

4. CONTROLS.

Name	*Adjustment*	*Function*
ON-OFF (toggle switch)	ON	Applies 115v a-c power to power transformer to start test set. Turns set heater off.
	OFF	Turns test set off. Turns set heater on.
METER BALANCE (potentiometer)	Adjust to balance meter.	Adjusts current through thermistor to set bridge meter reading to BALANCE. DBM dial must be set to maximum attenuation and TEST knob must be set to TRAN when adjustment is made.
DBM (calibrated output attenuator)	Adjust for SET POWER reading on meter. Read +7 to +30 dbm scale.	Measures average level of transmitter power in decibels above one milliwatt. (TEST knob must be set to TRAN position.)
	Adjust for SET POWER reading on meter. Read —42 to —83 dbm scale.	Measures peak power level of test signal output in decibels below one milliwatt. (TEST knob must be set to RECV position.)
TEST (function selector)	TRAN	Sets range of DBM for transmitter power measurements (+7 to +30 dbm scale). Cuts off test signal.
	(DOT)	Turns on test signal. Sets range of DBM for high level test signal outputs.
	RECV	Turns on test signal and sets range of DBM for measuring power of low level test signal output for receiver testing. (—40 to —83 dbm scale).
FREQUENCY (absorption frequency meter)	Tune to dip in bridge meter reading.	Tunes frequency meter to resonance at frequency being measured. Multiply dial reading by 10 to obtain frequency in megacycles.
PHASE (potentiometer)	Any position	Controls d-c reflector voltage on test oscillator tube. For c-w operation, selects operating mode for test oscillator. For f-m operation, adjusts time delay between trigger and center frequency of test signal. Shifts position of response curve along horizontal axis of oscilloscope.
POWER SET (test signal attenuator)	Adjust for SET POWER reading on meter.	Adjusts initial power level of test signal to balance bridge.
SIGNAL FREQ (test oscillator tuning)	Any position	Tunes test signal to desired frequency.
SIGNAL WIDTH (potentiometer)	Any position	Controls rate and deviation of test signal frequency modulation. Controls width of pattern on oscilloscope.

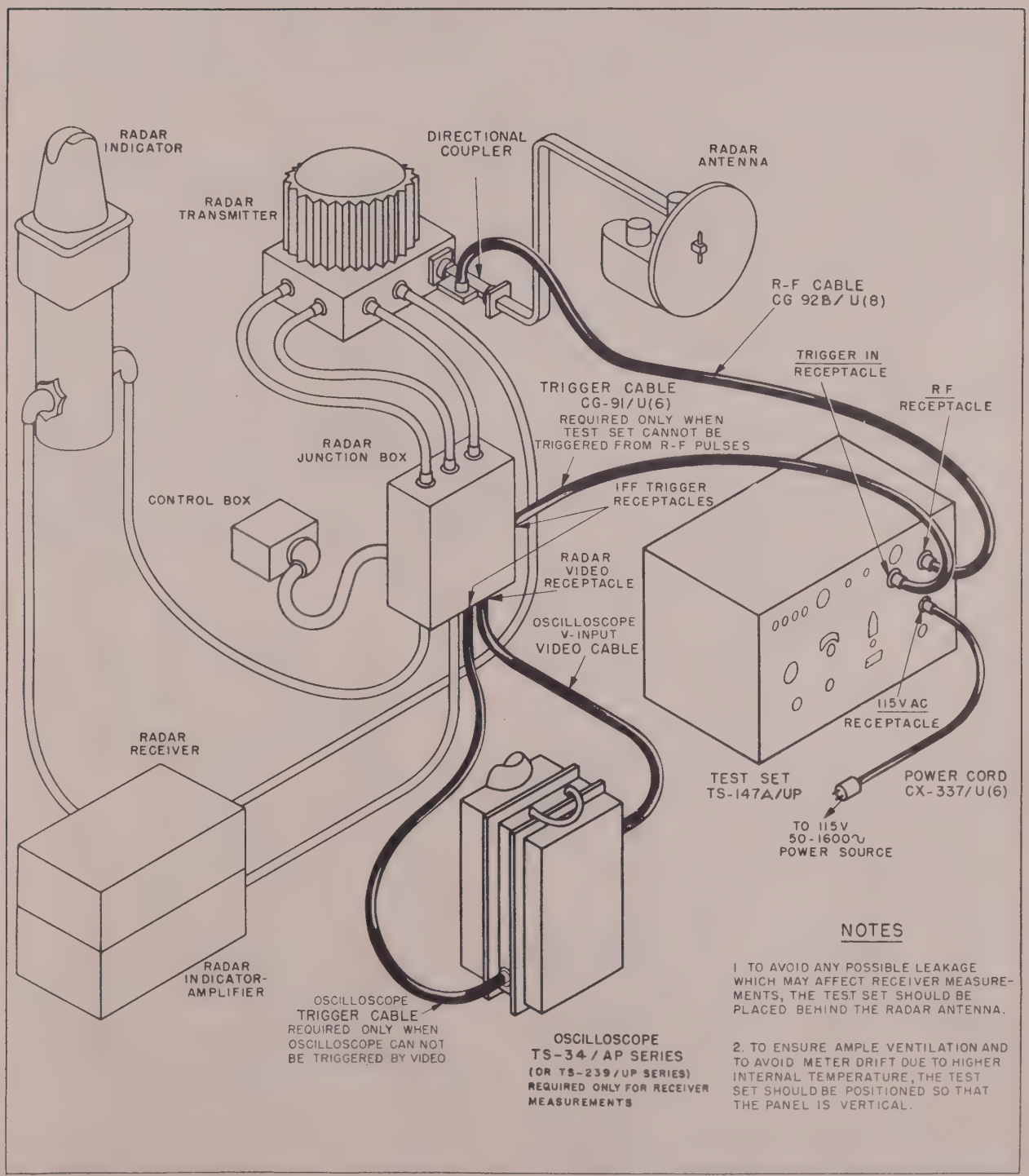

RADAR INDICATOR
DIRECTIONAL COUPLER
RADAR ANTENNA
RADAR TRANSMITTER
R-F CABLE CG 92B/U(8)
TRIGGER IN RECEPTACLE
TRIGGER CABLE CG-91/U(6)
REQUIRED ONLY WHEN TEST SET CANNOT BE TRIGGERED FROM R-F PULSES
R F RECEPTACLE
RADAR JUNCTION BOX
IFF TRIGGER RECEPTACLES
CONTROL BOX
RADAR VIDEO RECEPTACLE
OSCILLOSCOPE V-INPUT VIDEO CABLE
115 V AC RECEPTACLE
RADAR RECEIVER
TEST SET TS-147A/UP
POWER CORD CX-337/U(6)
TO 115V 50-1600~ POWER SOURCE
RADAR INDICATOR-AMPLIFIER
OSCILLOSCOPE TRIGGER CABLE
REQUIRED ONLY WHEN OSCILLOSCOPE CAN NOT BE TRIGGERED BY VIDEO
OSCILLOSCOPE TS-34/AP SERIES
(OR TS-239/UP SERIES)
REQUIRED ONLY FOR RECEIVER MEASUREMENTS
NOTES
1. TO AVOID ANY POSSIBLE LEAKAGE WHICH MAY AFFECT RECEIVER MEASUREMENTS, THE TEST SET SHOULD BE PLACED BEHIND THE RADAR ANTENNA.
2. TO ENSURE AMPLE VENTILATION AND TO AVOID METER DRIFT DUE TO HIGHER INTERNAL TEMPERATURE, THE TEST SET SHOULD BE POSITIONED SO THAT THE PANEL IS VERTICAL.

Figure 2-2. Complete Connections Using Directional Coupler

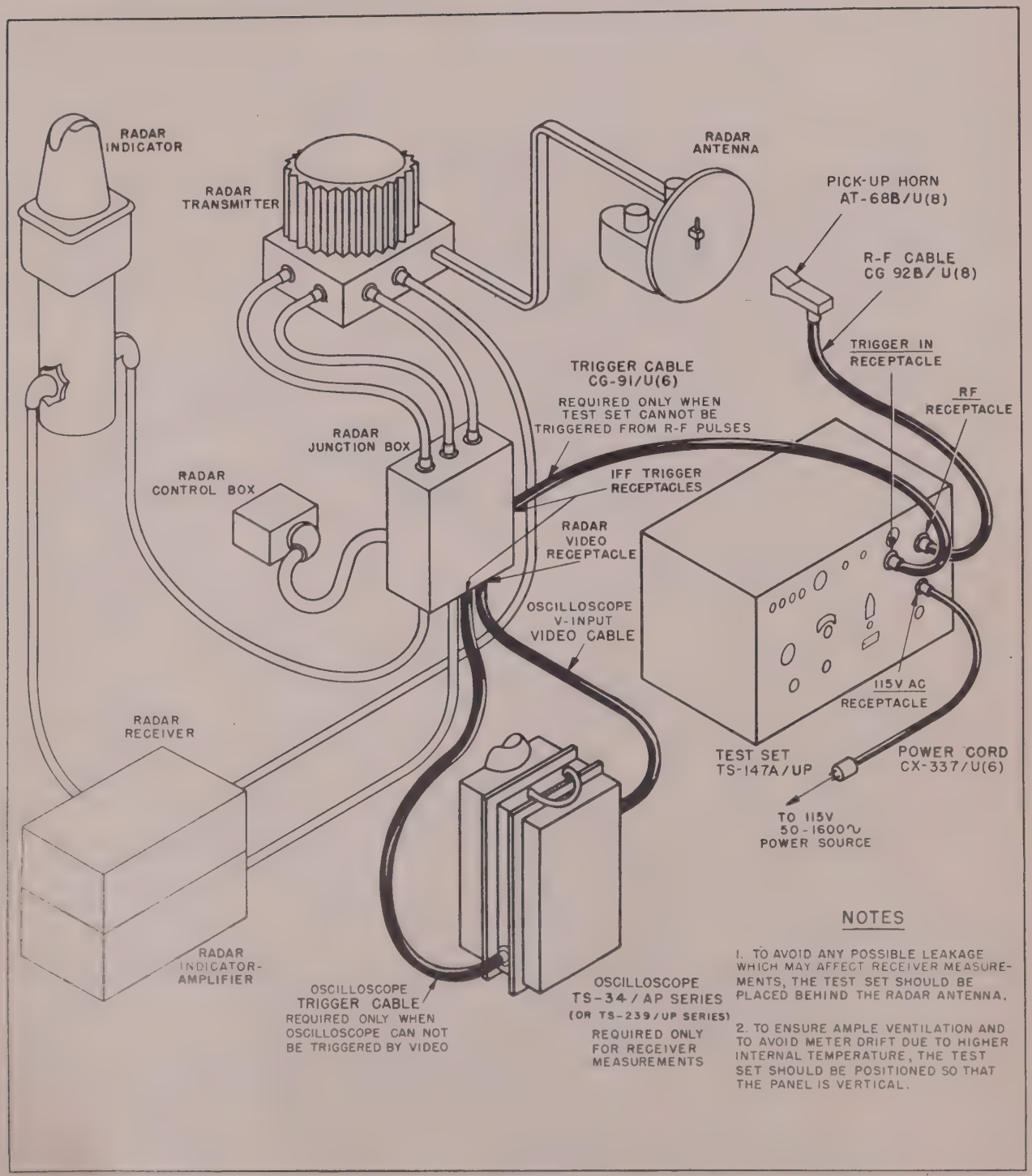

RADAR INDICATOR
RADAR TRANSMITTER
RADAR ANTENNA
PICK-UP HORN AT-68B/U(8)
R-F CABLE CG 92B/U(8)
TRIGGER IN RECEPTACLE
RF RECEPTACLE
TRIGGER CABLE CG-91/U(6)
REQUIRED ONLY WHEN TEST SET CANNOT BE TRIGGERED FROM R-F PULSES
RADAR JUNCTION BOX
RADAR CONTROL BOX
IFF TRIGGER RECEPTACLES
RADAR VIDEO RECEPTACLE
OSCILLOSCOPE V-INPUT VIDEO CABLE
115V AC RECEPTACLE
RADAR RECEIVER
TEST SET TS-147A/UP
POWER CORD CX-337/U(6)
TO 115V 50-1600~ POWER SOURCE
RADAR INDICATOR-AMPLIFIER
OSCILLOSCOPE TRIGGER CABLE
REQUIRED ONLY WHEN OSCILLOSCOPE CAN NOT BE TRIGGERED BY VIDEO
OSCILLOSCOPE TS-34/AP SERIES
(OR TS-239/UP SERIES)
REQUIRED ONLY FOR RECEIVER MEASUREMENTS
NOTES
1. TO AVOID ANY POSSIBLE LEAKAGE WHICH MAY AFFECT RECEIVER MEASUREMENTS, THE TEST SET SHOULD BE PLACED BEHIND THE RADAR ANTENNA.
2. TO ENSURE AMPLE VENTILATION AND TO AVOID METER DRIFT DUE TO HIGHER INTERNAL TEMPERATURE, THE TEST SET SHOULD BE POSITIONED SO THAT THE PANEL IS VERTICAL.

Figure 2-3. Complete Connections Using Pick-Up Horn

5. CONNECTIONS.

a. Use of the test set in the full scope of its applications requires four connections:

(1) Power must be supplied to operate the test set. For this connection use Power Cord CX-337/U connected to the 115V AC receptacle on the test set panel. The test set operates on 115 volts (±10%), 50 to 1600 cycle power.

(2) R-f coupling must be made between the test set and the radar system. For this connection use R-F Cable CG-92B/U connected to the RF receptacle on the test set panel. Either Pick-up Horn AT-68/UP or the directional coupler can be used to couple the cable to the radar system.

(3) Trigger for the test set sweep generator is required when the f-m test signals are to be used. A trigger is supplied by the r-f pulses applied to the RF receptacle without any additional connections or by any standard video trigger, such as IFF trigger, applied to the TRIGGER receptacle of the test set by means of the Trigger Cable CG-91/U.

(4) An Oscilloscope (TS-34/AP or TS-239/AP) connected to the video output of the radar receiver is used to indicate the response of the system by A-scan.

b. The first two connections, (1) and (2), are always required; connection (3) is necessary for tests on radar receivers. Complete connections are shown in figures 2-2 and 2-3.

Note

For many tests, the radar system indicator is satisfactory in place of the separate A-scope. An A-scope *is* necessary, however, for measuring receiver bandwidth and recovery time.

6. MEASURING RADAR PERFORMANCE.

Note

Each primary subdivision of this paragraph, i.e., 6*a*. 6*b*. 6*c*. etc. is complete in itself or contains all necessary references to previous tests. For an abridged procedure in which each primary subdivision is dependent upon the preceding, use paragraph 7, which is intended for use in making quick but complete performance test in connection with Radar Performance Data Sheets. (See sample in figure 2-10.)

a. PRELIMINARY PROCEDURE.

(1) PREPARE RADAR.—Turn radar on, observe modulator current, rectifier current, and crystal current. Leave radar spinner stationary.

(2) Prepare TS-147A/UP.

(*a*) SET CONTROLS:

Control	*Setting*
TEST	TRAN
DBM	All the way counter-clockwise.

(*b*) CONNECT TEST SET.—Make power, r-f, and trigger (if needed) connection specified in paragraph 5.

(3) PREPARE OSCILLOSCOPE (not used if Radar has A or J-Scope).—Use TS-34/AP, TS-239/AP or equivalent oscilloscope with sweep length of 50 to 100 microseconds.

(*a*) TS-34/AP.—Turn POWER ON; set to NORMAL; SWEEP SELECTOR to START-STOP; SWEEP SPEED to MED; INPUT IMPEDANCE to HIGH; ATTENUATION to 20 db. Switch to EXT SYNC and connect radar trigger to EXT SYNC (or use INT SYNC). Connect radar video signal to SIGNAL INPUT (TS-34/AP). Adjust INPUT IMPEDANCE and ATTENUATION for convenient signal height. Adjust SYNC VOLTAGE for steady signals (check SYNC POLARITY).

(*b*) TS-239/AP.—Set controls to equivalent settings.

b. MEASURING TRANSMITTER AVERAGE POWER (P_{av}).

(1) CONNECT TS-147A/UP TO RADAR.—Connect R-f Cable CG-92/U from RF receptacle to radar directional coupler (or test horn) as in figure 2-2 (or 2-3). Set TEST knob to TRAN and set DBM knob all the way counter-clockwise.

(2) TURN ON TS-147A/UP.—Connect 115V AC receptacle to power line with Power Cord CX-377/U. Turn 115V AC switch to ON and wait two minutes.

(3) BALANCE METER.—With TEST to TRAN and DBM full counter-clockwise, adjust METER BALANCE until meter is at BALANCE.

(4) SET POWER.—Turn DBM dial clockwise, reducing attenuation until meter pointer is below SET POWER. Detune FREQUENCY meter. Set meter to SET POWER by turning DBM dial counter-clockwise to take up backlash. Read DBM dial and record.

(5) COMPUTE TRANSMITTER AVERAGE POWER (P_{av}).—Compute as follows:

$$P_{av(dbm)} = +T1_{(dbm)} + A_{(db)} + C_{(db)}.$$

$P_{av(dbm)}$ = Transmitter Average Power (in decibels above one milliwatt).

$T1_{(dbm)}$ = Average r-f power entering the test set (in dbm). Reading of DBM dial in step (4).

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between test set and directional coupler (or horn) in decibels. See paragraph V.2. for r-f cable calibration.

$C_{(db)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

(6) COMPARE WITH RATED P_{av}.—Compare the measured value of transmitter average power (P_{av}) with the rated value. If the rated value is not given in dbm, convert to dbm by use of figure 2-8. If the rated peak power is known, compute rated average power by procedure of paragraph 6.*g.*(2).

c. MEASURING TRANSMITTER FREQUENCY (f_t).

(1) OBTAIN POWER INDICATION.—Perform the following operations, if not already performed.

Operation	*Paragraph*
Connect TS-147A/UP to Radar	6.*b.*(1)
Turn on TS-147A/UP	6.*b.*(2)
Balance Meter	6.*b.*(3)
Set Power	6.*b.*(4)

(2) OBSERVE FREQUENCY.—Tune FREQUENCY knob for dip in meter. Carefully set to maximum dip, turning FREQUENCY knob clockwise to avoid backlash. Record reading and multiply by ten to convert to megacycles.

CAUTION

A SECONDARY MODE IS PRESENT AT ABOUT HALF THE DIAL FROM THE PRIMARY MODE IN THE FREQUENCY METER CHARACTERISTIC. THE SECONDARY MODE GIVES A MUCH SMALLER DIP AND IS APPROXIMATELY FOUR TIMES AS WIDE. IT SHOULD BE AVOIDED WHEN MEASURING FREQUENCIES NEAR THE LIMITS OF THE FREQUENCY METER RANGE.

d.—MEASURING RECEIVER FREQUENCY.

(1) PREPARE RADAR, TEST SET, AND OSCILLOSCOPE.—Perform the following operations, if not already performed.

Operation	*Paragraph*
Prepare Radar	6.*a.*(1)
Prepare TS-147A/UP	6.*a.*(2)
Prepare Oscilloscope	6.*a.*(3)

(2) ADJUST RADAR RECEIVER.—Leave Automatic Frequency Control on (if operative), set gain high enough to show small grass on A-Scope and J-Scope.

(3) TUNE TEST SET TO RECEIVER.

(*a*) SET TS-147A/UP FOR TUNING.—Set TEST knob to (dot) position between TRAN and RCVR; DBM knob to about + 15 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid position.

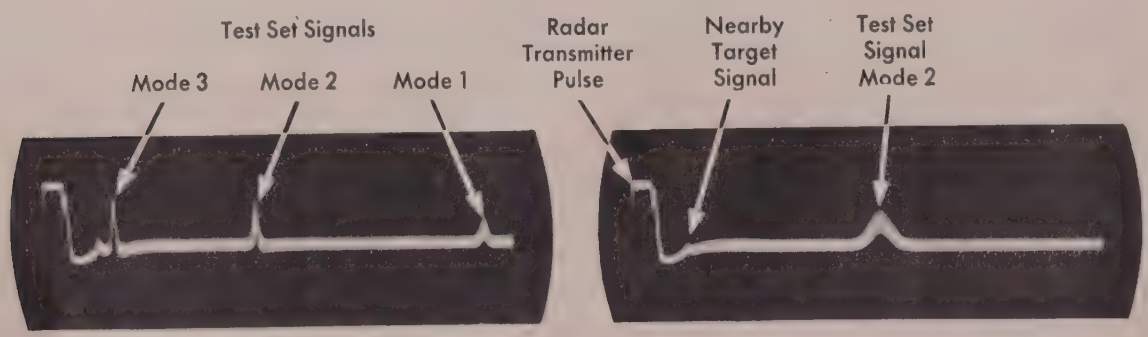
(*b*) OBTAIN FM SIGNAL.—Set SIGNAL WIDTH knob to MIN. Adjust SIGNAL FREQ knob for maximum signal; set TEST knob to RCVR and adjust DBM knob to prevent saturation (see figure 2-4 A). Proceed to step (5) unless no signal is obtained over the SIGNAL FREQ range.

(4) TUNE RECEIVER (if no test signals and test set is known to be operating properly).—Maximize crystal current with local oscillator manual reflector voltage control. Adjust coupling, if necessary, to obtain crystal current. Tune for maximum target signals or echo box signal and simultaneous maximum crystal current with local oscillator mechanical tuning. Readjust reflector voltage when necessary to obtain crystal current. Then tune test set to receiver as in step (3). If no target signals can be observed, tune receiver with test set, see paragraph 6.*k* page 2-12 (or use an echo box).

(5) MEASURE f_r.

(*a*) OBTAIN BANDPASS CURVE.—Turn SIGNAL WIDTH knob toward center to obtain bandpass curve. Adjust PHASE knob to hold pattern on oscilloscope screen. (See figure 2-4 B.)

(*b*) OBSERVE FREQUENCY.—Adjust FREQUENCY control so that pip is on top of bandpass curve. (See figure 2-5 A.) Record reading and multiply by ten. If f_r differs from f_t (or beacon), by twice the radar intermediate frequency, repeat paragraph 6*d.* (3) and select the alternative signal (clockwise rotation of SIGNAL FREQ decreases frequency). If the frequency differs from transmitter (or beacon) frequency other



A—Narrow FM Signals, SIGNAL WIDTH at MIN.

B—Bandpass Curve, SIGNAL WIDTH near Center of Range

Figure 2-4 Frequency Modulated Test Set Signals

than twice intermediate frequency, it would indicate AFC troubles. Look for defects in the following:

1. L. O. Tuning (see 6.*k.*).
2. Discriminator tuning.
3. AFC circuit.
4. Shock excitation of first i-f stage (AFC).
5. Bad spectrum.

e. MEASURING BANDWIDTH.

(1) OBTAIN BANDPASS CURVE.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar, Test Set, and Oscilloscope	6.*d.*(1)
Adjust Radar Receiver	6.*d.*(2)
Tune Test Set to Receiver	6.*d.*(3)
Tune Receiver (When necessary)	6.*d.*(4)
Measure Receiver Frequency	6.*d.*(5)

(2) MEASURE BANDWIDTH.—(See figure 2-5.)

(*a*) OBTAIN HALF POWER HEIGHT.—Increase the setting of DBM attenuator by 3.0 db, detune FREQUENCY meter, and mark half power height. Restore DBM to original setting.

(*b*) MEASURE FREQUENCY DIFFERENCE.—Move the FREQUENCY meter pip across the curve, observing the readings at the two points where it goes through the half power line determined in (*a*).

Bandwidth, $B = f_1 - f_2$.

Note

Sometimes when the frequency meter pip is tuned within the passband, the response curve on the oscilloscope is so distorted that it is difficult to set the positions of frequency meter pip to the half-power points with sufficient accuracy. An alternative procedure, to be used

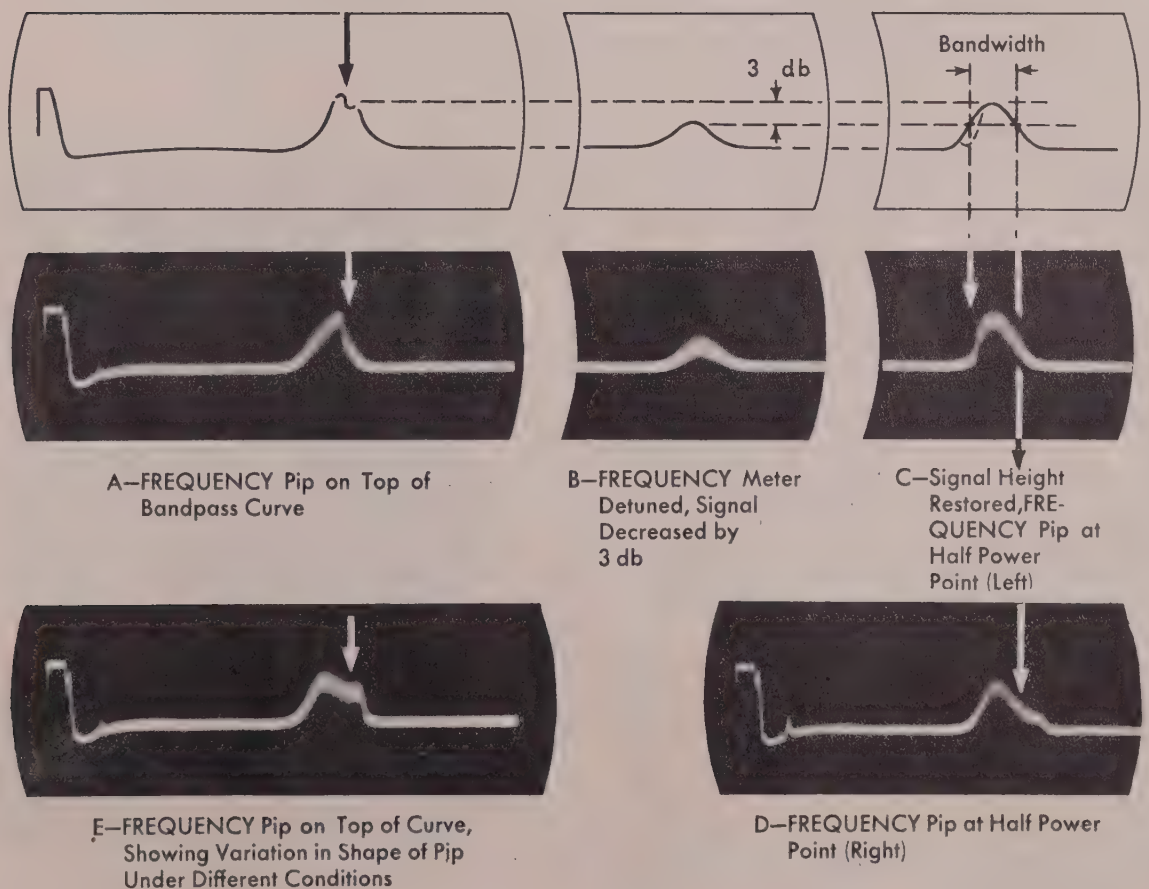

3 db
Bandwidth
A—FREQUENCY Pip on Top of Bandpass Curve
B—FREQUENCY Meter Detuned, Signal Decreased by 3 db
C—Signal Height Restored, FREQUENCY Pip at Half Power Point (Left)
E—FREQUENCY Pip on Top of Curve, Showing Variation in Shape of Pip Under Different Conditions
D—FREQUENCY Pip at Half Power Point (Right)

Figure 2-5 Receiver Frequency and Bandwidth Measurements

when this condition occurs, is to calibrate the horizontal sweep in megacycles-per-inch and measure directly the distance, and hence the frequency, between the two half-power points. The sweep calibration can be made by observing the distance the frequency meter dip moves when tuned over a definite frequency range. This calibration is dependent on the setting of the SIGNAL WIDTH knob and the PHASE knob, therefore, the setting of these knobs must not be changed after the calibration is made.

f. MEASURING RECEIVER PERFORMANCE FIGURE P_m (SENSITIVITY).—If receiver is not known to be tuned to transmitter, first check receiver frequency by following paragraph 6.*d.*

(1) PREPARE RADAR, TEST SET, AND OSCILLOSCOPE.—Perform the following operations, if not already performed.

Operation	*Paragraph*
Prepare Radar	6.*a.*(1)
Prepare TS-147A/UP	6.*a.*(2)
Prepare Oscilloscope	6.*a.*(3)

(2) ADJUST RADAR RECEIVER.—Leave Automatic Frequency Control on (if operative), set gain to show grass one-half of transmitter pulse or saturated signal amplitude.

(3) TUNE TEST SET TO RECEIVER.

(*a*) SET TS-147A/UP FOR RCVR TEST.—Set TEST knob to RCVR; DBM knob to about + 15 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid position.

(*b*) OBTAIN FM SIGNAL.—SET SIGNAL WIDTH knob to MIN. Adjust SIGNAL FREQ. knob for maximum signal, adjusting DBM knob to prevent saturation (see figure 2-4 A). If no test set signal can be obtained, set TEST knob to (dot) position to deliver a higher level test signal to the receiver. If still no test signal is found, tune receiver by procedure of paragraph 6.*d.*(4).

(4) CHECK METER BALANCE.—Set TEST to TRAN; DBM full counter-clockwise; then adjust METER BALANCE until meter is at BALANCE.

(5) FIND SIGNAL AGAIN.—Set TEST to RECV, turn DBM clockwise to find f-m signal again.

(6) SET SIGNAL POWER ON C-W.—Broaden bandpass curve to maximum by turning SIGNAL WIDTH knob clockwise to CW, while holding pattern on screen with PHASE knob. Detune FREQUENCY meter. Adjust POWER SET knob so that meter reads SET POWER.

(7) RETURN TO F-M SIGNAL.—Turn SIGNAL WIDTH carefully counter-clockwise to MIN, taking care to use same mode.

(8) DETERMINE MINIMUM DISCERNIBLE SIGNAL.—(see figure 2-6).—Turn DBM attenuator until signal just disappears in noise. When signal becomes as small as in part A of figure 2-6, turn the DBM knob in one db steps and move signal back and forth with PHASE knob for identification of signal. When the signal is last visible, read DBM dial.

(9) COMPUTE RECEIVER PERFORMANCE FIGURE:

$$P_{m(dbm)} = (-M_{(dbm)} - A_{(db)} - C_{(db)})$$

where:

$P_{m(dbm)}$ = Receiver performance figure in decibels below one milliwatt (—dbm). (Minimum discernible signal power converted to dbm.)

$M_{(dbm)}$ = Peak power output of the test set in dbm (DBM dial reading).

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between test set and directional coupler (or horn) in decibels.

$C_{(dbm)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

Example: See figure 2-10.

(10) COMPARE WITH RATED P_m.—Compare the measured value of Receiver Performance Figure, P_m, with the rated value. If the rated value is not given in dbm, convert to dbm by use of figure 2-8.

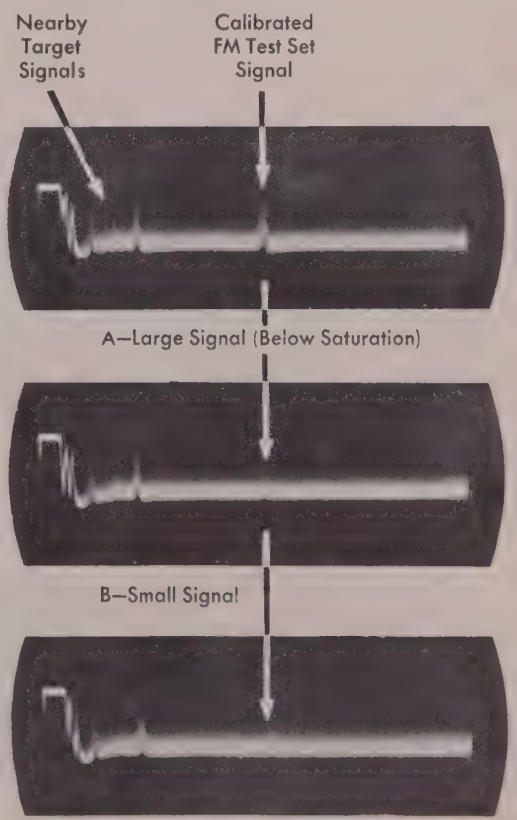


Figure 2-6 Measuring Minimum Discernible Signal Power

g. COMPUTING PERFORMANCE DATA.

(1) COMPUTING TRANSMITTER PERFORMANCE FIGURE.

(*a*) MEASURE TRANSMITTER AVERAGE POWER.—Follow procedure of paragraph 6.*b*.

(*b*) CONVERT TO TRANSMITTER PERFORMANCE FIGURE.—Compute as follows:

$$P_{pk(dbm)} = (P_{av(dbm)} + N_{(db)})$$

where:

$P_{pk(dbm)}$ = Transmitter performance figure in decibels above one milliwatt (+dbm) (transmitter peak power converted to dbm).

$P_{av(dbm)}$ = Transmitter average power in decibels above one milliwatt (+dbm).

$N_{(db)}$ = Number of decibels to be added to average power in dbm to convert to peak power in dbm (db due to duty cycle), (From figure 2-7).

Example:

$P_{av(dbm)}$ = 41.5 dbm.
pulse length = 1 microsecond.
pulse repetition rate = 650/sec.
From figure 2-7, $N_{(db)}$ = 31.5 db.
$P_{pk(dbm)}$ = 41.5 dbm + 31.5 db = +73 dbm.

(2) COMPUTING RATED TRANSMITTER AVERAGE POWER IN DBM.—If known in watts or kilowatts, convert to dbm by use of figure 2-8. If the rated peak power is known, proceed as follows:

(*a*) CONVERT RATED P_{pk} TO DBM.—Convert rated transmitter peak power from watts or kilowatts to dbm by use of figure 2-8. This figure is the rated transmitter performance figure, $P_{pk(dbm)}$.

(*b*) CONVERT RATED TRANSMITTER PERFORMANCE FIGURE TO RATED AVERAGE POWER.—Compute as follows:

$$P_{av(dbm)} = (P_{pk(dbm)} - N_{(db)}).$$

Example:

Rated P_{pk} = 40 kilowatts.
From figure 2-8, $P_{pk(dbm)}$ = +76 dbm.
For pulse length of 1 microsecond, pulse repetition rate of 650/sec, N = 31.5 db from figure 2-7.
Rated $P_{av(dbm)}$ = +76 −31.5 = +44.5 dbm.

(3) COMPUTING OVERALL PERFORMANCE.

(*a*) DETERMINING RADAR PERFORMANCE FIGURE, S.—The radar performance figure, S, is a measure of the ability of a radar to detect small or

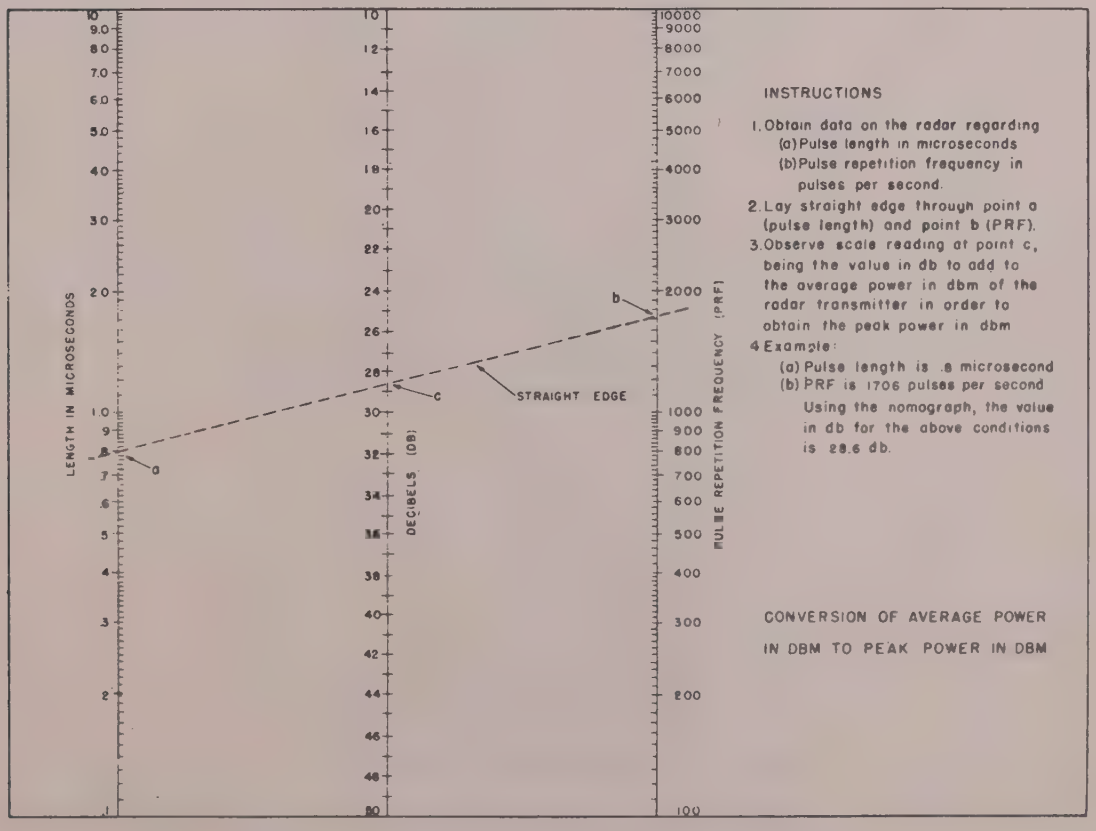

LENGTH IN MICROSECONDS
DECIBELS (DB)
PULSE REPETITION FREQUENCY (PRF)
STRAIGHT EDGE
a
b
c
INSTRUCTIONS
1. Obtain data on the radar regarding
(a) Pulse length in microseconds
(b) Pulse repetition frequency in pulses per second.
2. Lay straight edge through point a (pulse length) and point b (PRF).
3. Observe scale reading at point c, being the value in db to add to the average power in dbm of the radar transmitter in order to obtain the peak power in dbm
4 Example:
(a) Pulse length is .8 microsecond
(b) PRF is 1706 pulses per second
Using the nomograph, the value in db for the above conditions is 28.6 db.
CONVERSION OF AVERAGE POWER IN DBM TO PEAK POWER IN DBM

Figure 2-7 Average-to-Peak Power Conversion Chart

distant targets. The effect of external factors such as atmospheric conditions, geometry of target, ground and water reflection is not included in this figure.

(*1*) Compute the radar performance figure from $P_{kp(dbm)}$ obtained in paragraph II.6.*g*.(1) and $P_{m(dbm)}$ obtained in paragraph II.6.*f*. as follows:

$$S_{(db)} = P_{pk(dbm)} - P_{m(dbm)}.$$

Example:

$P_{pk(dbm)} = +73$ dbm.
$P_{m(dbm)} = -93$ dbm.
$S_{(db)} = +73 \text{ dbm} - (-93 \text{ dbm}) = 166$ db.

Note

When considering the ability of a radar to trigger a beacon and receiver, a beacon signal uses the transmitter performance figure $P_{pk(dbm)}$ and the receiver performance figure $P_{m(dbm)}$ separately, instead of combining them into the radar performance figure S.

(*2*) Compare the radar performance figure $S_{(db)}$ with the expected performance figure. The expected figure can be obtained from the expected values of $P_{pk(dbm)}$ and $P_{m(dbm)}$ or the value obtained when the radar is known to be operating satisfactorily.

Example: If the expected radar performance figure $S_{(db)} = 171$ db and the measured radar performance figure $S_{(db)} = 166$ db, the radar performance is down 5 db.

(*3*) The effect on range can be obtained by reference to the following table:

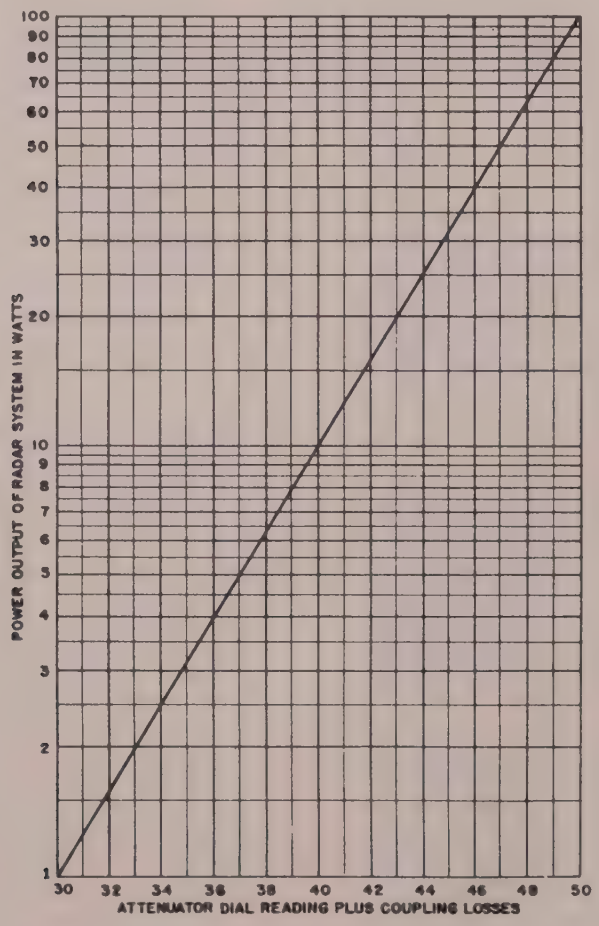


Figure 2-8 DBM-to-Watts Conversion Chart

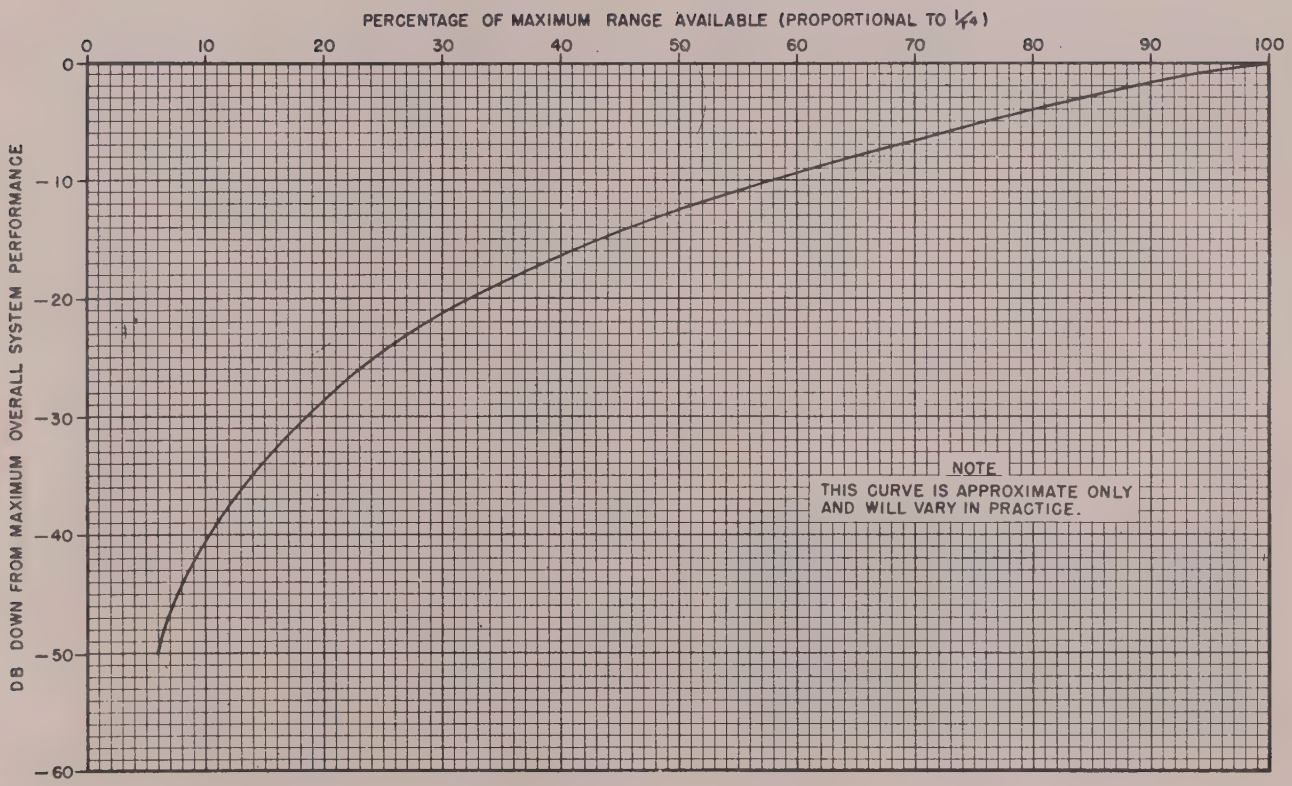


Figure 2-9. Radar Performance Versus Radar Range

Note

Where $P_{pk(dbm)}$ or $P_{av(dbm)}$ when measured on BEACON is down 2 db and $P_{m(dbm)}$ is down 1.5 db, the range at which the radar could trigger a beacon is down to 79% of normal range and the range at which the radar could receive a beacon signal is down 84% of normal range.

(*b*) COMPUTING CHANGE IN OVERALL PERFORMANCE.—For routine measurements, time can be saved by adding the differences from rated transmitter average power obtained in paragraph 6.*b*.(6) and rated receiver performance figure obtained in paragraph 6.*f*.(10) to get change in radar performance figure as is done in figure 2-10, Sample Radar Performance Data Sheet.

b. MEASURING TR RECOVERY TIME.—There is an alternate method for measuring TR Recovery Time (or C-W). See paragraph V.4.

(1) OBTAIN F-M SIGNAL.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar, Test Set and Oscilloscope	6.*d*.(1)
Adjust Radar Receiver	6.*d*.(2)
Tune Test Set to Receiver	6.*d*.(3)
Tune Receiver (if no test signals are obtained)	6.*d*.(4)

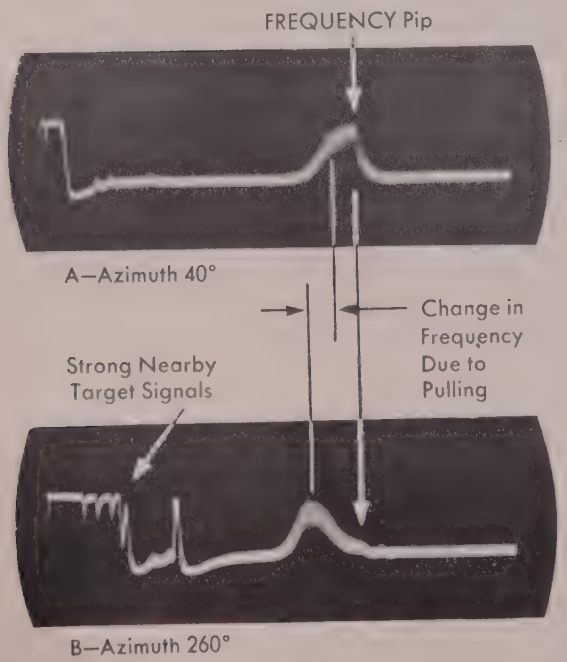


Figure 2-10. Checking Transmitter Pulling and AFC Tracking

(2) ADJUST SIGNAL HEIGHT.—Leave AFC on if operative. Adjust gain for small grass. Adjust DBM knob until signal height is about half way between noise and saturation.

(3) PHASE SIGNAL TOWARD TRANSMITTER PULSE.—Turn PHASE knob counter-clockwise toward MIN until signal height starts to decrease. Measure range from beginning of transmitter pulse to signal.

i. DETECTING TRANSMITTER PULLING AND CHECKING AFC TRACKING.

(1) OBTAIN FM SIGNAL.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar, Test Set, and Oscilloscope	6.*d*.(1)
Adjust Radar Receiver	6.*d*.(2)
Tune Test Set to Receiver	6.*d*.(3)
Tune Receiver (if no test signals are obtained)	6.*d*.(4)

(2) OBTAIN BANDPASS F-M SIGNAL.—Turn PHASE knob clockwise to put signal near center of screen. Broaden signal by turning SIGNAL WIDTH knob part way clockwise. Set FREQUENCY meter for pip on top of curve (f_t).

(3) CHECK FOR PULLING AND PROPER AFC TRACKING.—Start radar antenna spinner. If the F-M signal moves, there is probably pulling (see figure 2-9(4)). If it remains on the screen, the AFC is tracking all right.

j. CHECKING BEACON RESPONSE OF RADAR.

(1) PRELIMINARY.—Switch radar to BEACON, measure crystal current, rectifier current, and modulator current.

(2) MEASURE TRANSMITTER POWER.—Follow paragraph 6.*b*. (Most radars have different pulse length and repetition rate on Beacon).

(3) MEASURE TRANSMITTER FREQUENCY.—Follow paragraph 6.*c*.

(4) MEASURE RECEIVER FREQUENCY FOR BEACON RECEPTION.—Follow paragraph 6.*d*. substituting 9310 mc for transmitter frequency. First tune beacon receiver by procedure of paragraph 6.*k*. if there is no beacon AFC or tuning cavity.

(5) MEASURE RECEIVER PERFORMANCE FIGURE FOR BEACON RECEPTION.—Follow paragraph 6.*f*.

k. TUNING RADAR RECEIVERS. (For use when results are not satisfactory in paragraph 6.*d*. or when there is no AFC.)

(1) PREPARE RADAR, TEST SET, AND OSCILLOSCOPE.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar	6.*a*.(1)
Prepare TS-147A/UP	6.*a*.(2)
Prepare Oscilloscope	6.*a*.(3)

(2) ADJUST RADAR RECEIVER.—Set radar on manual tuning. Set gain high enough to show small grass on A or J-Scope.

(3) SET TS-147A/UP FOR RCVR TEST.—Set TEST knob to RCVR; DBM knob to about + 50 dbm; POWER Set, knob near maximum (clockwise); PHASE knob near mid position.

(4) TUNING RECEIVER TO TRANSMITTER (OR BEACON) FREQUENCY.—(To be used, if necessary, after paragraph 6.d.(4).)

(*a*) SET TS-147A/UP ON CW.—Turn SIGNAL WIDTH knob clockwise to CW. Maximize meter reading with PHASE control. Leave TEST on RCVR, set DBM to about — 50 dbm.

(*b*) SET TS-147A/UP TO TRANSMITTER (or BEACON) FREQUENCY.—Adjust SIGNAL FREQ. knob to transmitter (or beacon) frequency, resetting PHASE knob when meter drops 10%, checking frequency by dipping meter with FREQUENCY control.

(*c*) SET TS-147A/UP ON FM.—Turn SIGNAL WIDTH knob to MIN. Set TEST knob to (dot).

(*d*) DETUNE RECEIVER LOCAL OSCILLATOR.—Set radar on manual tuning. Set local oscillator at extreme end of tuning range, but on correct side of transmitter (or beacon) frequency. Adjust local oscillator for crystal current.

(*e*) TUNE RECEIVER TO TS-147A/UP.—Tune receiver local oscillator mechanical tuning slowly toward center of its range, resetting reflector voltage when crystal current drops, watching for FM signal on oscilloscope. Tune mechanical tuner of receiver for maximum FM signal, and maximum crystal current. Set TEST knob to RCVR. Then adjust setting of DBM attenuator, if necessary, to prevent saturation.

(*f*) OBTAIN F-M BANDPASS CURVE.—Carefully broaden the SIGNAL WIDTH while holding the signal in view with the PHASE control until bandpass curve is obtained. Adjust local oscillator to get FREQUENCY pip on top of curve.

(4) ADJUST RADAR R-F COMPONENTS. — Tune TR and ATR for maximum TS-147A/UP signal. Adjust DBM attenuator to avoid saturated signal while tuning. Adjust crystal current for proper value. Readjust L-O, TR, and ATR to compensate for interaction.

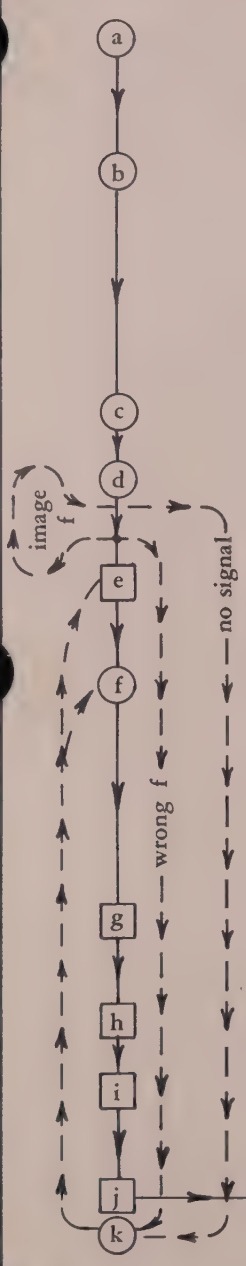
(5) COMPARE AFC AND MANUAL.—Switch to AFC. If pattern moves more than a few megacycles frequency, adjust AFC discriminator secondary. If pattern disappears on AFC, either the AFC is inoperative or the manual tuning is on the wrong side of the transmitter frequency.

DETACH HERE

T. O. No. 16-35TS147-11

RADAR PERFORMANCE DATA SHEET

Radar_____ Serial No._____ TS-147A/UP No._____ Observer_____ Date_____



SEARCH

Preliminary Procedure

Radar Modulator Current ..... _____ma

Radar Rectifier Current ..... _____ma

Radar Crystal Current ..... _____ma

Transmitter Average Power

DBM Dial Reading ..... _____dbm

Cable Attenuation ..... A_____db

Coupling ..... C_____db

Total ..... P_{av}_____dbm

Rated ..... _____dbm

Difference ..... _____db

Transmitter Frequency

Reading_____, Frequency.... f_t_____Mc

Receiver Frequency

Reading ..... _____

Frequency ..... f_r_____Mc

Receiver Bandwidth

Readings (1)_____ (2)_____

Bandwidth, f_1_____ f_2_____B_____Mc

Receiver Performance Figure (Sensitivity)

DBM Dial Reading..... _____dbm

Cable Attenuation ..... —A_____db

Coupling ..... —C_____db

Total ..... P_m_____dbm

Rated ..... —(_____)dbm

Difference ..... _____db

Overall Performance

Differences _____db .... _____db

Overall Difference ..... (b-f)_____db

TR Recovery

Range ..... _____miles

Transmitter Pulling; AFC Tracking

Transmitter Pulling: No ☐ Yes ☐

AFC Tracking....Good ☐ Poor ☐

Beacon Response of Radar

Receiver Tuning

BEACON

j(1) Preliminary

_____ma

_____ma

_____ma

j(2) Trans. P_{av}

_____dbm

A_____db

C_____db

P_{av}_____dbm

_____dbm

_____db

j(3) f_t on Beacon

f_t_____Mc

j(4) f_r for Beacon

_____

f_r_____Mc

j(5) P_m for Beacon

_____dbm

—A_____db

—C_____db

P_m_____dbm

—(_____) dbm

_____db

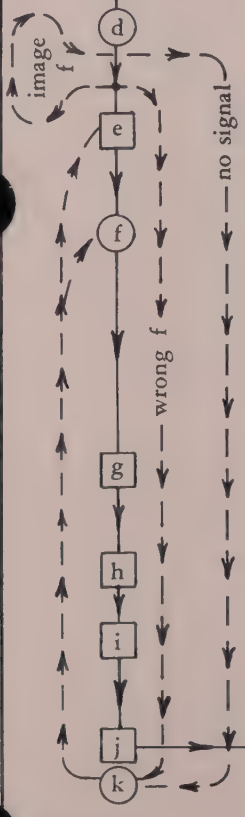
Maintenance Notes:

DETACH HERE

T. O. No. 16-35TS147-11

RADAR PERFORMANCE DATA SHEET

Radar_____ Serial No._____ TS-147A/UP No._____ Observer_____ Date_____



SEARCH

Preliminary Procedure
- Radar Modulator Current ..... _____ma
- Radar Rectifier Current ..... _____ma
- Radar Crystal Current ..... _____ma

Transmitter Average Power
- DBM Dial Reading ..... _____dbm
- Cable Attenuation ..... A_____db
- Coupling ..... C_____db
- Total ..... P_{av}_____dbm
- Rated ..... _____dbm
- Difference ..... _____db

Transmitter Frequency
- Reading_____, Frequency.... f_t_____Mc

Receiver Frequency
- Reading ..... _____
- Frequency ..... f_r_____Mc

Receiver Bandwidth
- Readings (1)_____ (2)_____
- Bandwidth, f_1_____ f_2_____B_____Mc

Receiver Performance Figure (Sensitivity)
- DBM Dial Reading..... _____dbm
- Cable Attenuation ..... —A_____db
- Coupling ..... —C_____db
- Total ..... P_m_____dbm
- Rated ..... —(_____)dbm
- Difference ..... _____db

Overall Performance
- Differences _____db .... _____db
- Overall Difference ..... (b-f)_____db

TR Recovery
- Range ..... _____miles

Transmitter Pulling; AFC Tracking
- Transmitter Pulling: No ☐ Yes ☐
- AFC Tracking....Good ☐ Poor ☐

Beacon Response of Radar

Receiver Tuning

BEACON

j(1) Preliminary
_____ma
_____ma
_____ma

j(2) Trans. P_{av}
_____dbm
A_____db
C_____db
P_{av}_____dbm
_____dbm
_____db

j(3) f_t on Beacon
f_t_____Mc

j(4) f_r for Beacon
_____
f_r_____Mc

j(5) P_m for Beacon
_____dbm
—A_____db
—C_____db
P_m_____dbm
—(_____) dbm
_____db

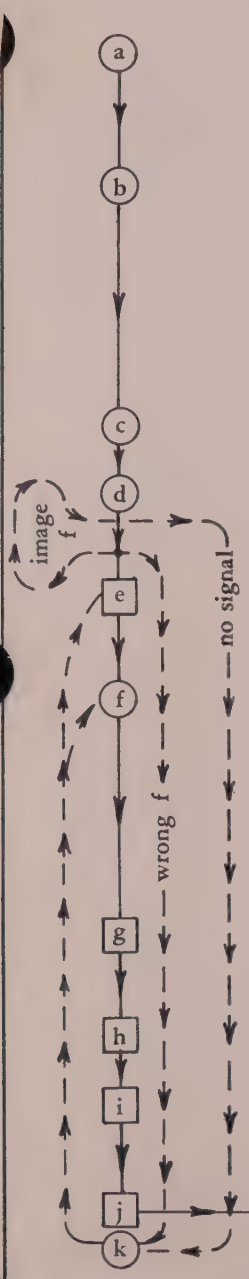
Maintenance Notes:

DETACH HERE

T. O. No. 16-35TS147-11

RADAR PERFORMANCE DATA SHEET

Radar_____ Serial No._____ TS-147A/UP No._____ Observer_____ Date_____



SEARCH

Preliminary Procedure
- Radar Modulator Current ..... _____ ma
- Radar Rectifier Current ..... _____ ma
- Radar Crystal Current ..... _____ ma

Transmitter Average Power
- DBM Dial Reading ..... _____ dbm
- Cable Attenuation ..... A _____ db
- Coupling ..... C _____ db
- Total ..... P_{av} _____ dbm
- Rated ..... _____ dbm
- Difference ..... _____ db

Transmitter Frequency
- Reading _____, Frequency .... f_t _____ Mc

Receiver Frequency
- Reading ..... _____
- Frequency ..... f_r _____ Mc

Receiver Bandwidth
- Readings (1) _____ (2) _____
- Bandwidth, f_1 _____ f_2 _____ B _____ Mc

Receiver Performance Figure (Sensitivity)
- DBM Dial Reading ..... _____ dbm
- Cable Attenuation ..... —A _____ db
- Coupling ..... —C _____ db
- Total ..... P_m _____ dbm
- Rated ..... —(_____) dbm
- Difference ..... _____ db

Overall Performance
- Differences _____ db .... _____ db
- Overall Difference ..... (b-f) _____ db

TR Recovery
- Range ..... _____ miles

Transmitter Pulling; AFC Tracking
- Transmitter Pulling: No ☐ Yes ☐
- AFC Tracking .... Good ☐ Poor ☐

Beacon Response of Radar

Receiver Tuning

BEACON

j(1) Preliminary
- _____ ma
- _____ ma
- _____ ma

j(2) Trans. P_{av}
- _____ dbm
- A _____ db
- C _____ db
- P_{av} _____ dbm
- _____ dbm
- _____ db

j(3) f_t on Beacon
- f_t _____ Mc

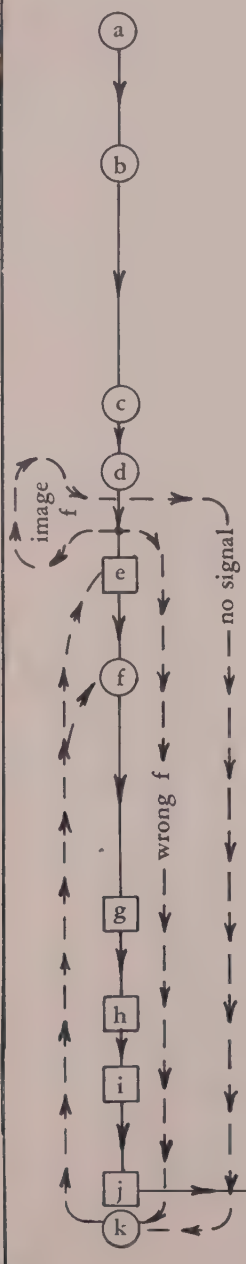
j(4) f_r for Beacon
- _____
- f_r _____ Mc

j(5) P_m for Beacon
- _____ dbm
- —A _____ db
- —C _____ db
- P_m _____ dbm
- —(_____) dbm
- _____ db

Maintenance Notes:

RADAR PERFORMANCE DATA SHEET

Radar_____ Serial No._____ TS-147A/UP No._____ Observer_____ Date_____



SEARCH

Preliminary Procedure

Radar Modulator Current ..... _____ma
Radar Rectifier Current ..... _____ma
Radar Crystal Current ..... _____ma

Transmitter Average Power

DBM Dial Reading ..... _____dbm
Cable Attenuation ..... A_____db
Coupling ..... C_____db
Total ..... P_{av}_____dbm
Rated ..... _____dbm
Difference ..... _____db

Transmitter Frequency

Reading_____, Frequency.... f_t_____Mc

Receiver Frequency

Reading .....
Frequency ..... f_r_____Mc

Receiver Bandwidth

Readings (1)_____ (2)_____
Bandwidth, f_1_____ f_2_____B_____Mc

Receiver Performance Figure (Sensitivity)

DBM Dial Reading..... _____dbm
Cable Attenuation ..... —A_____db
Coupling ..... —C_____db
Total ..... P_m_____dbm
Rated ..... —(_____)dbm
Difference ..... _____db

Overall Performance

Differences _____db .... _____db
Overall Difference ..... (b-f)_____db

TR Recovery

Range ..... _____miles

Transmitter Pulling; AFC Tracking

Transmitter Pulling: No ☐ Yes ☐
AFC Tracking....Good ☐ Poor ☐

Beacon Response of Radar
Receiver Tuning

BEACON

j(1) Preliminary
_____ma
_____ma
_____ma

j(2) Trans. P_{av}
_____dbm
A_____db
C_____db
P_{av}_____dbm
_____dbm
_____db

j(3) f_t on Beacon
f_t_____Mc

j(4) f_r for Beacon
_____
f_r_____Mc

j(5) P_m for Beacon
_____dbm
—A_____db
—C_____db
P_m_____dbm
—(_____) dbm
_____db

Maintenance Notes:

(4) COMPARE WITH RATED P_m—Compute difference from rated P_m.

g. OVERALL PERFORMANCE.—Combine the difference from parts *b* and *e* of the data sheet to obtain the difference in overall performance figure from rated performance figure.

h. TR RECOVERY TIME.—Leave AFC on, if operative. Adjust gain for small grass.

(1) RESTORE F-M SIGNAL (which disappeared in paragraph 8.*f.*(3).).—Turn DBM knob clockwise until signal height is about half way between noise and saturation.

(2) PHASE SIGNAL TOWARD TRANSMITTER PULSE.—Turn PHASE knob counter-clockwise toward MIN until signal height starts to decrease. Measure range from beginning of transmitter pulse to signal.

i. DETECTING TRANSMITTER PULLING AND CHECKING AFC TRACKING.

(1) OBTAIN BANDPASS F-M SIGNAL.—Turn PHASE knob clockwise to put signal near center of screen. Broaden signal by turning SIGNAL WIDTH part way clockwise. Set FREQUENCY meter for pip on top of curve (f_t).

(2) CHECK FOR PULLING AND PROPER AFC TRACKING.—Start radar antenna spinner. If the F-M signal moves, there is probably pulling. If it remains in synchronism with the spinner, the AFC is tracking all right.

j. BEACON RESPONSE OF RADAR.

(1) PRELIMINARY.—Switch radar to BEACON, measure crystal current and modulator current.

(2) MEASURE TRANSMITTER POWER.—Follow paragraph 7.*b.* (Most radars have different pulse length and repetition rate on Beacon.)

(3) MEASURE TRANSMITTER FREQUENCY.—Follow paragraph 7.*c.*

(4) MEASURE RECEIVER FREQUENCY FOR BEACON RECEPTION.—Follow paragraph 7.*d.*, substituting the beacon frequency for transmitter frequency. First tune beacon receiver by procedure of paragraph 7.*k.*, if there is no beacon AFC or tuning cavity.

(5) MEASURE RECEIVER PERFORMANCE FIGURE FOR BEACON RECEPTION.—Follow paragraph 7.*c.*

k. RECEIVER TUNING. (*For use when results are not satisfactory in paragraph 7.d. or there is no AFC.*).—Switch radar from AFC to manual tuning.

(1) TUNE RECEIVER TO TRANSMITTER (OR BEACON) FREQUENCY. (*To be used, if necessary, after paragraph* 7.*d.*(2).)

(*a*) SET TS-147A/UP ON CW.—Turn SIGNAL WIDTH clockwise to CW. Maximize meter reading with PHASE control. Leave TEST on RCVR, set DBM to about —50 dbm.

(*b*) SET TS-147A/UP TO TRANSMITTER (or BEACON) FREQUENCY.—Adjust SIGNAL FREQ to transmitter (or beacon) frequency resetting PHASE when meter drops 10%, checking frequency by dipping meter with FREQUENCY control.

(*c*) SET TS-147A/UP ON FM.—Turn SIGNAL WIDTH to MIN. Set TEST to (dot).

(*d*) DETUNE RECEIVER LOCAL OSCILLATOR.—Set radar on manual tuning. Set local oscillator at extreme end of tuning range, but on correct side of transmitter (or beacon) frequency. Adjust local oscillator for crystal current.

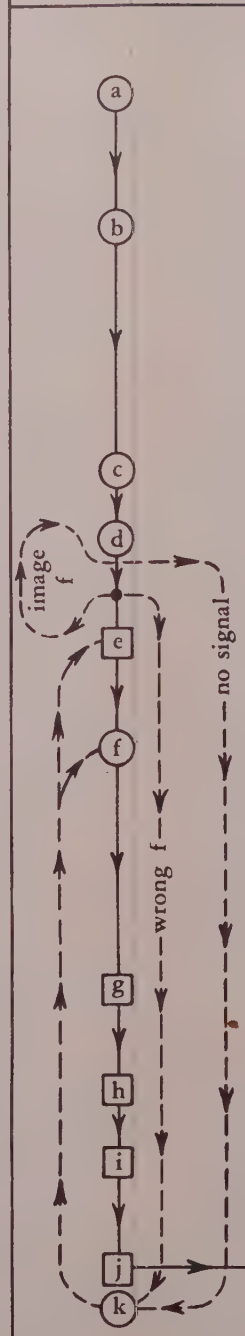
(*e*) TUNE RECEIVER TO TS-147A/UP.—Turn radar local oscillator mechanical tuning slowly toward center of its range, resetting the reflector voltage when crystal current drops, watching for FM signal on oscilloscope. Tune mechanical tuner of receiver for maximum FM signal and adjust reflector voltage for maximum crystal current. Set TEST to RCVR. Then adjust setting of DBM attenuator, if necessary, to prevent saturation.

(*f*) OBTAIN F-M BANDPASS CURVE.—Carefully broaden the SIGNAL WIDTH while holding the signal in view with the PHASE control until bandpass curve is obtained. Adjust local oscillator to get FREQUENCY pip on top of curve.

(2) ADJUST RADAR R-F COMPONENTS.—Tune TR and ATR for maximum TS-147A/UP signal. Adjust DBM attenuator to avoid saturated signal while tuning. Adjust crystal current for proper value. Readjust L-O, TR, and ATR to compensate for interaction.

(3) COMPARE AFC AND MANUAL.—Switch to AFC. If pattern moves more than half the bandwidth, the AFC needs adjustment. If pattern disappears on AFC, either the AFC is inoperative or the manual tuning is on the wrong side of the transmitter frequency.

(4) CONTINUE WITH PERFORMANCE CHECK.—Return to paragraph 7.*d.*(2).



Radar AN/APS-15A Serial No. 1725 TS-147A

SEARCH

Preliminary Procedure
Radar Modu
Radar Rectifi
Radar Crysta

Transmitter Average Power
DBM Dial F
Cable Attenu
Coupling .
Total .....
Rated .....
Difference .

Transmitter Frequency
Reading 93

Receiver Frequency
Reading ...
Frequency .

Receiver Bandwidth
Readings (1
Bandwidth,

Receiver Performance Figure (
DBM Dial F
Cable Atten
Coupling .
Total .....
Rated .....
Difference .

Overall Performance
Differences(
Overall Diff

TR Recovery
Range ....

Transmitter Pulling; AFC Tra
Transmitter
AFC Track

Beacon Response of Radar
Receiver Tuning

Maintenance Notes:

Figure 2-11. Samp

RMANCE DATA SHEET

UP No. 2 Observer FBI Date 2/15/49

		BEACON	
		j(1) Preliminary	
or Current	7.5 ma		7.0 ma
Current	9.0 ma		8.6 ma
Current	0.6 ma		0.55 ma
		j(2) Trans. P_{av}	
ading	+17.5 dbm		+18.5 dbm
tion A	4 db		A 4 db
C	20 db		C 20 db
P_{av}	+41.5 dbm		P_{av} +42 dbm
	+44.5 dbm		+44.5 dbm
	-3 db		-2 db
		j(3) f_t on Beacon	
5, Frequency f_t	9365 Mc		f_t 9365 Mc
		j(4) f_r for Beacon	
	936.6		931.0
f_r	9366 Mc		f_r 9310 Mc
936.5 (2)	936.7		
9365 f_2	9367 B 2 Mc		
nsitivity)			
ading	-69 dbm	j(5) P_m for Beacon	-59.5 dbm
tion —A	-4 db		—A -4 db
—C	-20 db		—C -20 db
P	-93 dbm		P_m -83.5 dbm
—(	-95) dbm		—(-85) dbm
	-2 db		-1.5 db
-3 db	(f) +2 db		
ence (b-f)	-5 db		
	0.2 miles		

ing
Pulling: No ☑ Yes ☐
g....Good ☑ Poor ☐

Radar Performance Data Sheet

7. MEASURING RADAR PERFORMANCE (abridged).

Note

These abridged instructions are for use in sequence. Sub-paragraphs which may be skipped without upsetting following paragraphs are enclosed in square ☐ blocks on Blank Radar Performance Data Sheet. To perform individual tests out of sequence, refer to paragraph 6.

a. PRELIMINARY PROCEDURE.

(1) RADAR.—Turn radar on, observe modulator current, rectifier current, and crystal current. Leave radar spinner stationary.

(2) TS-147A/UP.—Turn TEST to TRAN; DBM all the way counter-clockwise. Connect and turn 115V AC to ON. Connect cable CG-92/U cable from RF to radar directional coupler (or test horn).

(3) TS-34/AP (Not used if Radar has A or J-Scope). — Turn POWER ON; set to NORMAL; SWEEP SELECTOR to START-STOP; SWEEP SPEED to MED; INPUT IMPEDANCE to HIGH; ATTENUATION to 20 db. Switch to EXT SYNC and connect radar trigger to EXT SYNC (or use INT SYNC). Connect radar video signal to SIGNAL INPUT (TS-34/AP). Adjust INPUT IMPEDANCE and ATTENUATION for convenient signal height. Adjust SYNC VOLTAGE for steady signals (check SYNC POLARITY).

b. TRANSMITTER AVERAGE POWER (P_{av}).

(1) BALANCE METER.—With TEST to TRAN and DBM full counter-clockwise, adjust METER BALANCE until meter is at BALANCE.

(2) SET POWER.—Turn DBM dial clockwise, reducing attenuation until meter pointer is below SET POWER. Detune FREQUENCY meter. Set meter to SET POWER by turning DBM dial counter-clockwise to take up backlash. Read DBM dial and record.

(3) COMPUTE TRANSMITTER AVERAGE POWER (P_{av}).—Compute as follows:

P_{av} = + DBM reading + A + C. (See Blank Radar Performance Data Sheet.)

(4) COMPARE WITH RATED P_{av}. — Compute difference from rated P_{av}.

c. TRANSMITTER FREQUENCY (f_t). — Tune FREQUENCY knob for dip in meter. Carefully set to maximum dip turning FREQUENCY knob clockwise to avoid backlash. Record reading and multiply by ten.

d. RECEIVER FREQUENCY.—Leave radar AFC on (if operative) and set gain sufficient to show small grass.

(1) TUNE TEST SET TO RECEIVER.

(*a*) SET TS-147A/UP FOR TUNING.—Set TEST to (dot) position between TRAN and RCVR; DBM to — 15 dbm; POWER SET near maximum (clockwise); phase near mid position.

(*b*) OBTAIN FM SIGNALS.—Set SIGNAL WIDTH to MIN. Adjust SIGNAL FREQ for maximum signal; set TEST to RCVR and adjust DBM knob to prevent saturation. Proceed to step (3) unless no signal is obtained over the SIGNAL FREQ range.

(2) TUNE RECEIVER (If no test signals).—Maximize crystal current with local oscillator manual reflector voltage control. Adjust coupling, if necessary, to obtain crystal current. Tune for maximum target signals or echo box signal with local oscillator mechanical tuning. Readjust reflector voltage when necessary to obtain maximum crystal current. Then tune test set to receiver as in step (1). If no target signals can be observed, tune receiver with test set, see paragraph 7.*k.* (or use echo box).

(3) MEASURE f_r.

(*a*) OBTAIN BANDPASS CURVE. — Turn SIGNAL WIDTH to obtain bandpass curve. Adjust PHASE control to hold pattern on oscilloscope screen.

(*b*) OBSERVE FREQUENCY.—Adjust FREQUENCY control so that pip is on top of bandpass curve. Record reading and multiply by ten. If f_r differs from f_t (or beacon) by twice the radar intermediate frequency, repeat paragraph 7.*d.*(1) and select the alternative signal (clockwise rotation of SIGNAL FREQ decreases frequency). If the frequency differs from transmitter (or beacon) frequency, by other than twice intermediate frequency, AFC trouble is indicated. If AFC is inoperative, see paragraph 7.*k.* for manual tuning.

e. MEASURE BANDWIDTH (Optional).

(1) OBTAIN HALF POWER HEIGHT.—Increase the setting of DBM attenuator by 3.0 db; detune FREQUENCY meter; and mark height. Restore DBM to original setting.

(2) MEASURE FREQUENCY DIFFERENCE.—Move the FREQUENCY meter pip across the curve, observing the readings at the two points where it goes through the half power line determined in (*a*).

Bandwidth, $B = f_1 - f_2$.

f. RECEIVER PERFORMANCE FIGURE P_m (SENSITIVITY).—Leave Radar AFC on (if operative) and set gain to show grass one-half of main bang amplitude.

(1) SET SIGNAL POWER ON C-W.—Broaden bandpass curve to maximum by turning SIGNAL WIDTH clockwise to CW, while holding pattern on screen with PHASE control. Detune FREQUENCY meter. Adjust POWER SET knob so that meter reads SET POWER.

(2) RETURN TO F-M SIGNAL.—Turn SIGNAL WIDTH to MIN, being careful to keep the correct signal for use.

(3) DETERMINE MINIMUM DISCERNIBLE SIGNAL.—Turn DBM attenuator until signal just disappears in noise. Move signal back and forth with PHASE knob for identification. Record DBM dial reading. Compute receiver performance figure:

P_m = —DBM reading — A — C (See Radar Performance Data Sheet.)

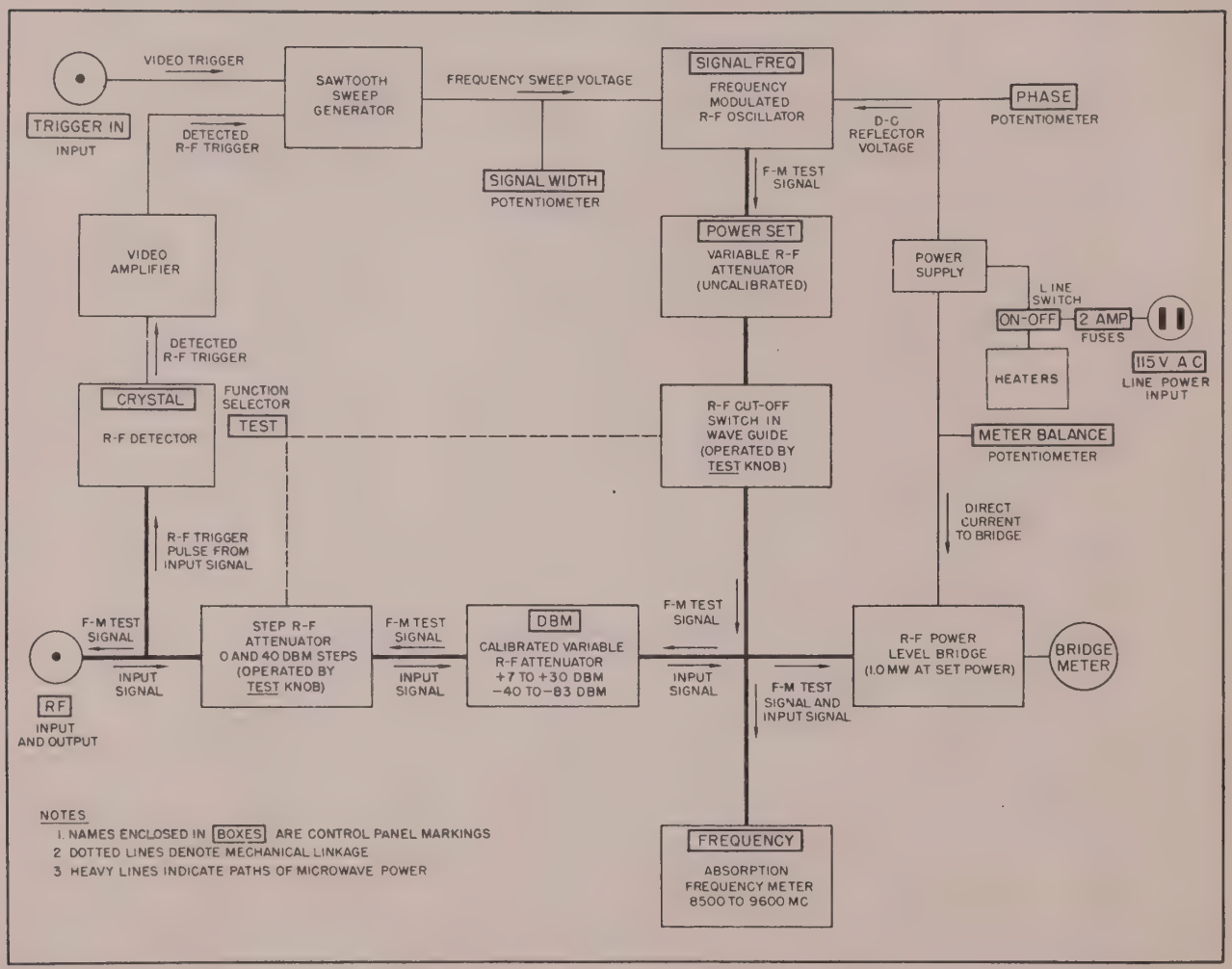


Figure 3-1. Test Set **TS–147A/UP**
Block Diagram

SECTION III
THEORY OF OPERATION

1. GENERAL.

a. This section describes and explains in detail the operating principles of each component in the test set.

2. PRINCIPLES OF OPERATION.

a. A block diagram of the test set components and their interconnections is shown in figure 3-1. The test signals are generated by the test oscillator which is frequency modulated by the sawtooth voltage supplied by the triggered sweep generator. The sweep generator is triggered in synchronism with the system firing cycle either by means of voltage pulses connected to the TRIGGER input receptacle or by means of pulse r-f power detected and amplified by the detector crystal and trigger amplifier.

b. The output of the test oscillator is controlled directly by means of the POWER SET attenuator and the r-f cut-off. The POWER SET attenuator provides adjustment of the signal level applied to the thermistor bridge. The r-f cut-off is a wave guide switch which serves as a means for turning the output of the oscillator on or off.

c. The output level of the test signal is measured by the DBM attenuator. When the POWER SET attenuator is adjusted so the thermistor bridge is balanced, the DBM dial indicates directly the test signal power level at the RF receptacle. The step attenuator, operated by the TEST knob, sets the range of the DBM attenuator. When the TEST knob is in RECV position the DBM range is —42 to —83 dbm; for (dot) posi-

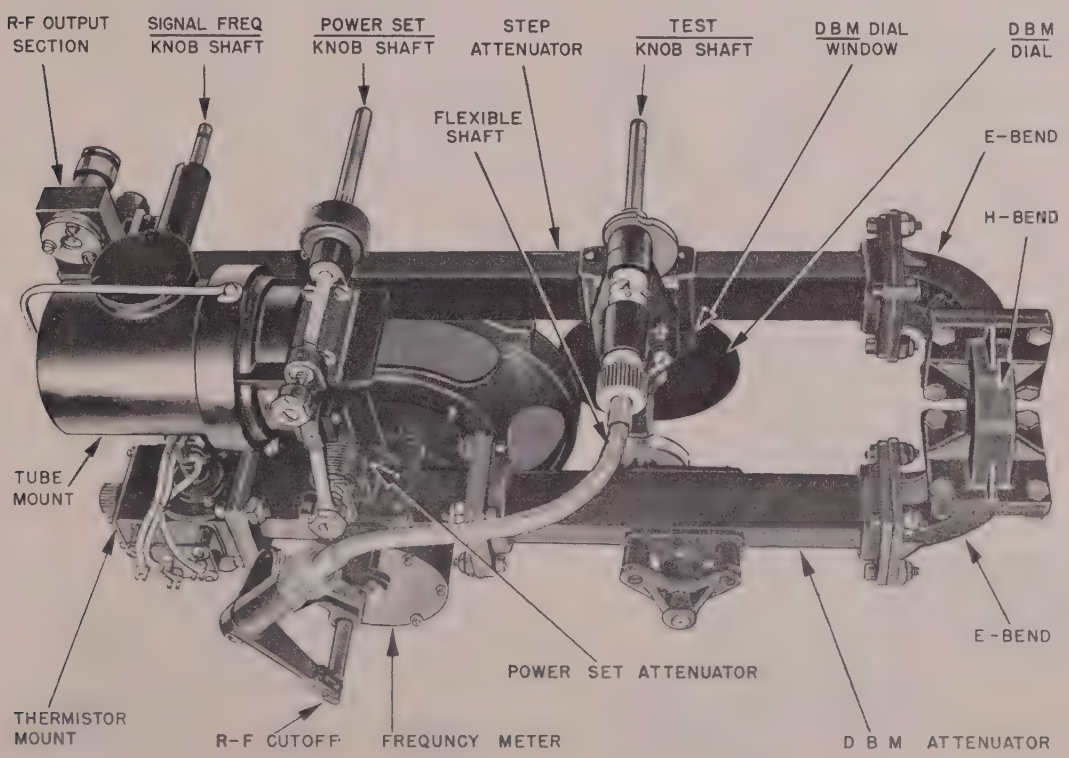


Figure 3-2. R-F Plumbing Arrangement

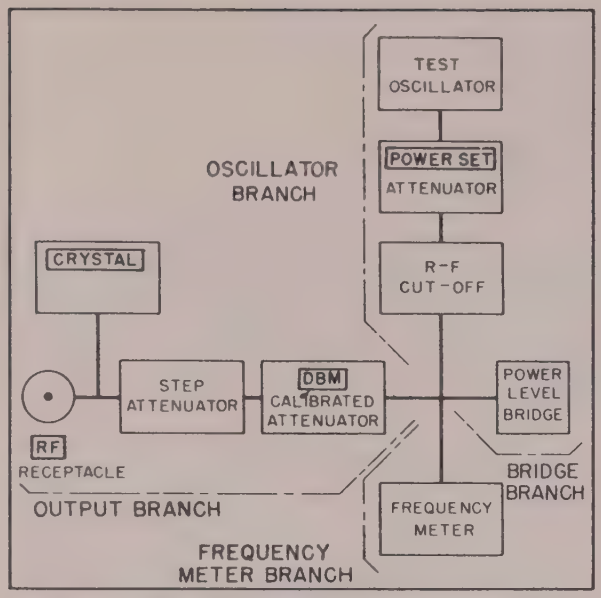


Figure 3-3. Simplified Block Diagram Showing Plumbing Branches

tion, the DBM range is approximately —7 to —30 dbm for readings of +7 to +30, but calibration for this range is approximate only.

d. The frequency of the test signal is measured by the frequency meter. When the frequency meter cavity is tuned to the test signal frequency, part of the power from the test oscillator is reflected and a dip in the bridge meter reading is produced. The reflection of the frequency meter also causes a decrease in the power output of the test set. If the test signal is frequency modulated and the frequency meter is tuned within the range of the frequency sweep, power will be absorbed at each time that the frequency sweep reaches the resonant frequency of the frequency meter. The instantaneous decrease in power output resulting from the absorption will appear as a small negative pip in the frequency response curve seen on the A-scope. See figure 2-5.

e. In addition to operating as a signal generator, the test set also measures the power and frequency of external r-f signals applied to the test set. Power is measured by means of the DBM attenuator and the thermistor bridge wattmeter. For this measurement the TEST knob is set to TRAN position to close the r-f cutoff and set the DBM attenuator range to +7 to +30 dbm. The DBM attenuator is then adjusted to decrease the input power to the level which balances the thermistor bridge wattmeter. At this point, the power level at the bridge is 1.0 milliwatt and the DBM dial indicates directly the input power level in dbm (decibels above 1.0 milliwatt).

f. Frequency of input signals is measured by the same means used for test signals. At resonance the frequency meter absorbs part of the power applied to the thermistor bridge and causes a dip in the bridge meter reading.

3. R-F PLUMBING COMPONENTS.

a. GENERAL.

(1) Figure 3-2 shows the physical layout of the r-f plumbing components in the test set. The plumbing components are wave guide sections fitted with attachments or modifications to vary the way in which r-f power is transmitted through them. Most of the components are fixed assemblies which cannot be disassembled in the field for maintenance or repair. Some components are calibrated assemblies which if taken apart in the field can no longer effect accurate measurements. In any case, however, each component is replaceable as a complete unit which can be easily removed or inserted in the set.

(2) The arrangement of the plumbing comprises three branches; namely, the input (or output) branch, the oscillator branch, and the bridge branch. The three branches join in a T-section at which junction the wavemeter is located. The three branches described are designated in figure 3-3 and will be referred to by these names in locating components in the ensuing descriptions.

(3) The component assemblies of the r-f plumbing are connected by means of a gasket-flange joint (figure 3-4). These joints replace the more fa-

Figure 3-4. Gasket-Flange Joint

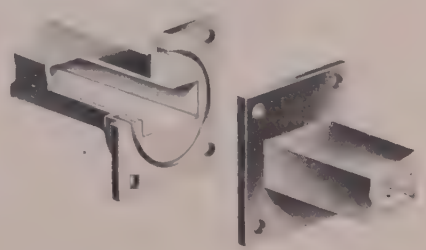


Figure 3-5. Choke-Flange Joint.

miliar choke-flange joints (figure 3-5) used in most 3.2-cm band plumbing systems. The gasket-flange joint consists of two flanges between which is sandwiched a thin copper gasket of the same shape as the flange face. The joint is fastened by means of four screws, one through each corner of the flanges and gasket.

b. TUBE MOUNT ASSEMBLY (figures 3-6 and 3-7).

(1) The tube mount contains the test oscillator tube (V104) and the POWER SET attenuator. The mount is a section of wave guide on which is attached an octal tube socket and shield can. When the oscillator tube is inserted in the socket, the output probe of the tube projects into the wave guide and serves as an antenna to radiate r-f power down the guide. The distance from the output probe to the shorted end of the guide is effectively one-quarter wavelength so that energy radiated toward the shorted end is reflected back in phase with the energy radiated toward the output.

(2) The POWER SET attenuator adjusts the power from the test oscillator tube transmitted to the other plumbing components. The attenuator consists of a rectangular strip of glass coated with resistive material. Since the electric field strength varies from maximum at the center of the wave guide to zero at the edge, the power dissipated by the glass strip increases as the strip is moved toward the center of the guide.

(3) The metal case placed around the oscillator tube acts as an r-f shield to reduce r-f leakage from the oscillator. It also shields the oscillator tube from air currents which would cause variations in frequency due to change in temperature.

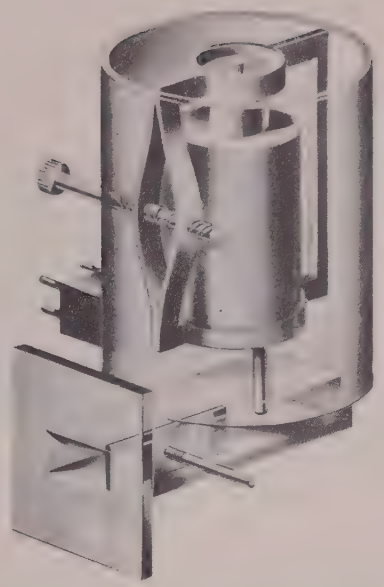


Figure 3-6. Tube Mount Assembly Simplified Phantom View

c. FREQUENCY METER ASSEMBLY (figures 3-8 and 3-9).

(1) The frequency meter assembly consists of the frequency meter resonator and dial together with a T-section of wave guide which contains the r-f cut-off. The T-section connects the assembly to the three branches of the plumbing defined in figure 3-3. The r-f cut-off is a sliding door which opens and closes the opening of the oscillator branch at the junction of the T.

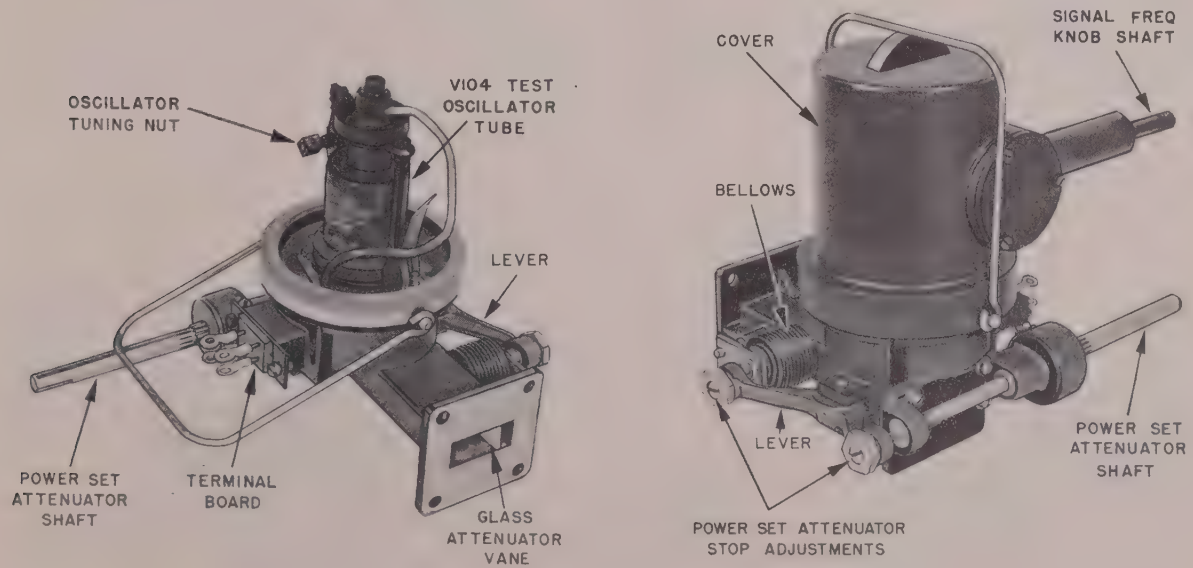


Figure 3-7. Tube Mount Assembly

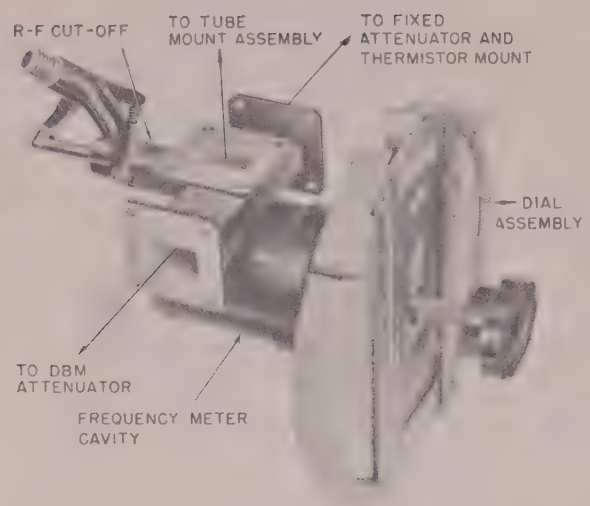


Figure 3-8. Frequency Meter Assembly

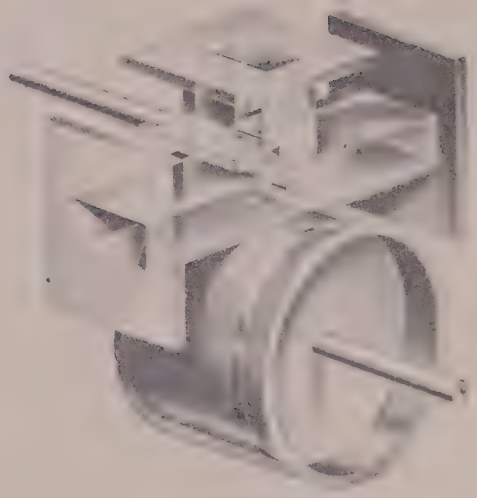


Figure 3-9. Frequency Meter Assembly Simplified Phantom View

(2) The frequency meter is a cylindrical cavity resonator, the volume of which is adjustable by means of a plunger. The cavity is coupled to the T-section by means of a hole in the wave guide opposite the r-f cut-off. When the length of the cavity is adjusted to one-half wavelength, the cavity resonates and presents a low impedance at the hole coupling. As a result, some of the transmitted power incident on the T-section is reflected by the cavity thus causing a decrease in the power level at the thermistor bridge.

d. THERMISTOR MOUNT ASSEMBLY (figures 3-10 and 3-11).

(1) The thermistor mount is a section of wave guide which contains the thermistor element of the thermistor bridge circuit. The bead thermistor is mounted parallel to the voltage field in the wave guide. A matching stub and a shorting plug are provided to match the section impedance to the connecting plumbing components.

(2) Two disc thermistors for temperature compensation are mounted on the outside of the wave guide. These thermistors have relatively large mass and their resistance is affected principally by the ambient temperature of the thermistor mount. The operation of the thermistor bridge circuit is described in paragraph 4.*d.* of this section.

(3) The meter shunt resistor, R201, attached to the thermistor mount, changes the sensitivity of the bridge meter to correspond to the sensitivity of the thermistor bridge. This makes the thermistor mounts

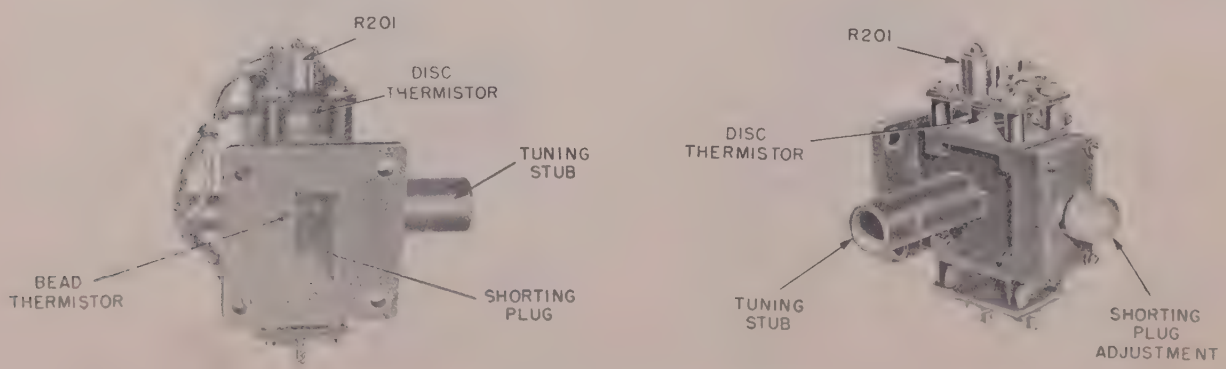


Figure 3-10. Thermistor Mount

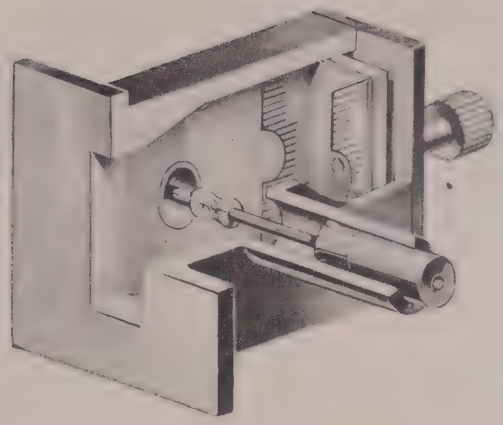


Figure 3-11. Thermistor Mount Simplified Phantom View

interchangeable without affecting the accuracy of power measurements.

e. DBM CALIBRATED ATTENUATOR (figures 3-12 and 3-13).—The DBM attenuator is a section of wave guide which contains a movable rectangular glass vane coated with resistive material. The vane mounts on two sliding rods by means of which the position of the vane can be adjusted between the side and the center of the wave guide. The two rods are driven by a linear cylindrical cam operated by the DBM knob. The vane is parallel to the electric field in the wave guide. Since the electric field strength increases from zero at the side of the guide to a maximum at the center of the guide, the loss caused by the attenuator increases as the vane is moved towards the center of the wave guide.

f. STEP ATTENUATOR (figures 3-14 and 3-15).

(1) The step attenuator is a variable attenuator (similar to the DBM attenuator in principle) used in series with the DBM attenuator to increase the attenuation range of the test set. The step attenuator differs from the DBM attenuator in the type of cam drive used to move the glass vane across the wave guide. Instead of a linear cylindrical cam, the step attenuator uses a disc cam with three detents. Two of the detents position the cam follower and the attenuator vane for minimum attenuation. The third detent sets the attenuation to a higher value. The

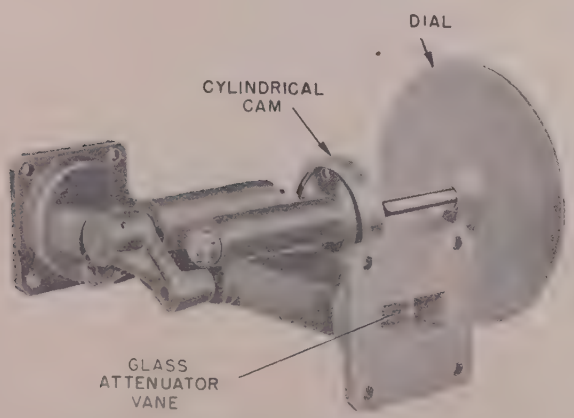


Figure 3-12. DBM Calibrated Attenuator

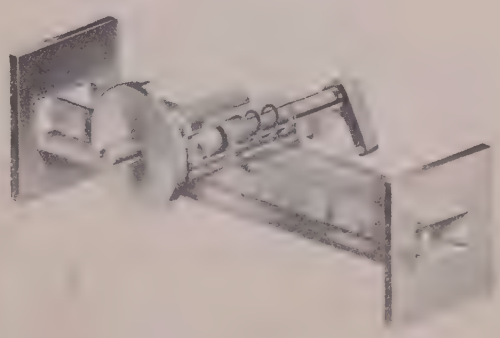


Figure 3-13. DBM Calibrated Attenuator Simplified Phantom View

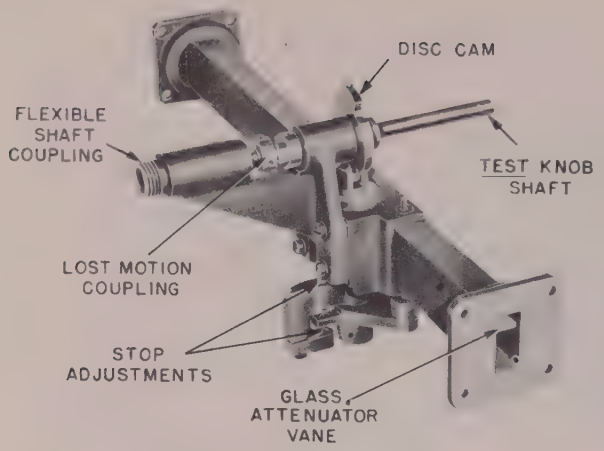


Figure 3-14. Step Attenuator

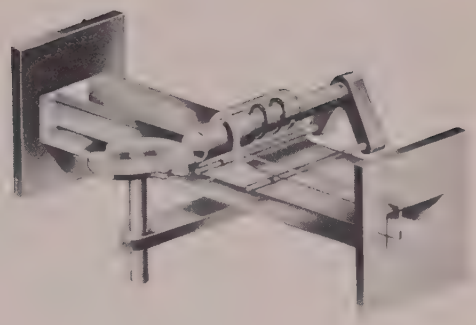


Figure 3-15. Step Attenuator Simplified Phantom View

resulting action produces two steps or levels of attenuation.

(2) The step attenuator cam is operated by the TEST knob. The cam is set in the minimum level detents when the TEST knob is set to the TRAN and (dot) positions. For these settings the range of the DBM dial is 7 to 30 dbm. In RECV position the TEST knob sets the cam in the third or high level detent to change the DBM range —42 to 80 dbm.

g. R-F OUTPUT AND DETECTOR SECTION figures 3-16 and 3-17).

(1) The output section consists of a coax-to-wave guide coupling and a crystal detector. The coax coupling couples the RF receptacle to the wave guide plumbing. The center conductor of the RF receptacle projects into the wave guide and is in effect an antenna which radiates into the guide. The shorted end of the guide acts as a reflector located one-quarter wave length behind the coax probe.

(2) The crystal detector portion of the output section is another section of wave guide which is slot coupled to the main section. The secondary section is terminated by a silicon rectifier crystal capsule which detects pulse r-f power for triggering the sweep generator.

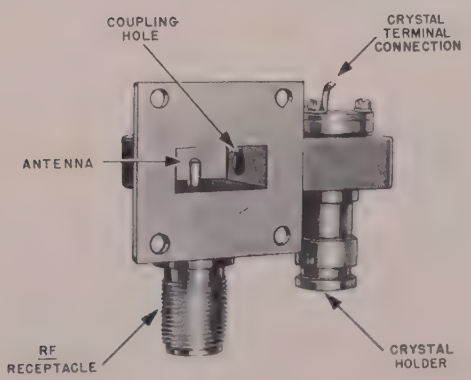


Figure 3-16. R-f Output and Detector Section

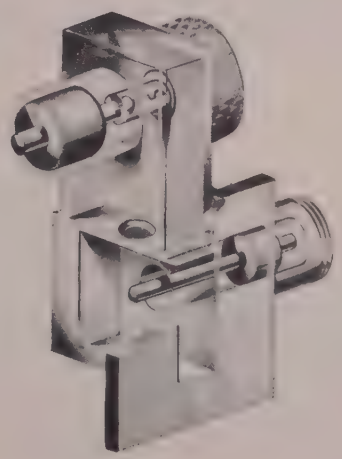


Figure 3-17. R-f Output and Detector Section Simplified Phantom View

4. ELECTRICAL CIRCUITS.

a. TRIGGER DETECTOR AND AMPLIFIER CIRCUIT (figure 3-18).

(1) The trigger detector and amplifier circuit provides the means for triggering the frequency sweep generator from pulse r-f power applied to the RF receptacle. The r-f pulses are detected by the crystal, Y101, in the output coupling section and the resulting pulse voltage is applied to the input of the trigger amplifier. The amplifier is a three-stage resistance-coupled amplifier consisting of one and one-half 6SL7 twin triodes, V107A, B and V108A. The voltage gain is approximately 500. The output of the amplifier supplies a voltage pulse which can trigger the blocking oscillator sweep circuit. The output pulse is parallel fed through C111 to the blocking oscillator transformer, T102.

(2) Video triggers applied to the TRIGGER receptacle of the test set are amplified by the last stage of the amplifier. The voltage trigger pulses feed through C115 directly to the grid of V108A.

b. BLOCKING OSCILLATOR SWEEP CIRCUIT (figure 3-19).

(1) The frequency sweep circuit for the test oscillator is a sawtooth generator of the triggered blocking oscillator type. The blocking oscillator consists of one-half 6SL7 twin triode (V108B) and a three-winding transformer (T102). The circuit comprises a conventional blocking oscillator except that the grid is biased below cutoff so that a trigger pulse must be applied to start each cycle oscillation. The grid bias is applied to the cathode by the voltage divider R134 and R135.

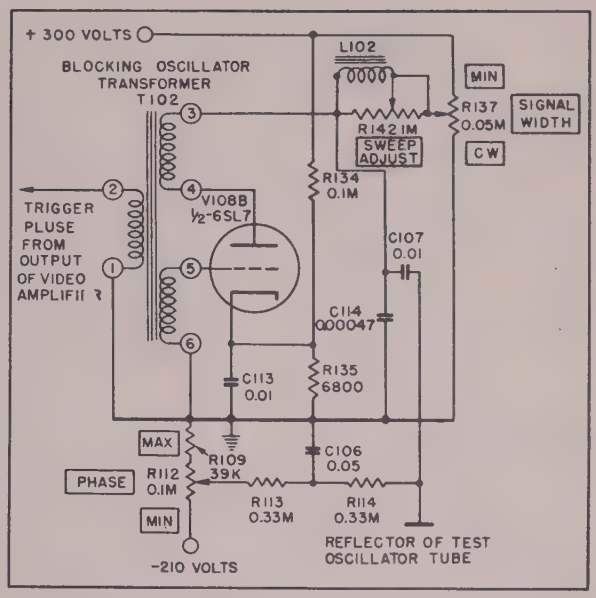


Figure 3-19. Blocking-Oscillator Sweep Circuit Simplified Schematic

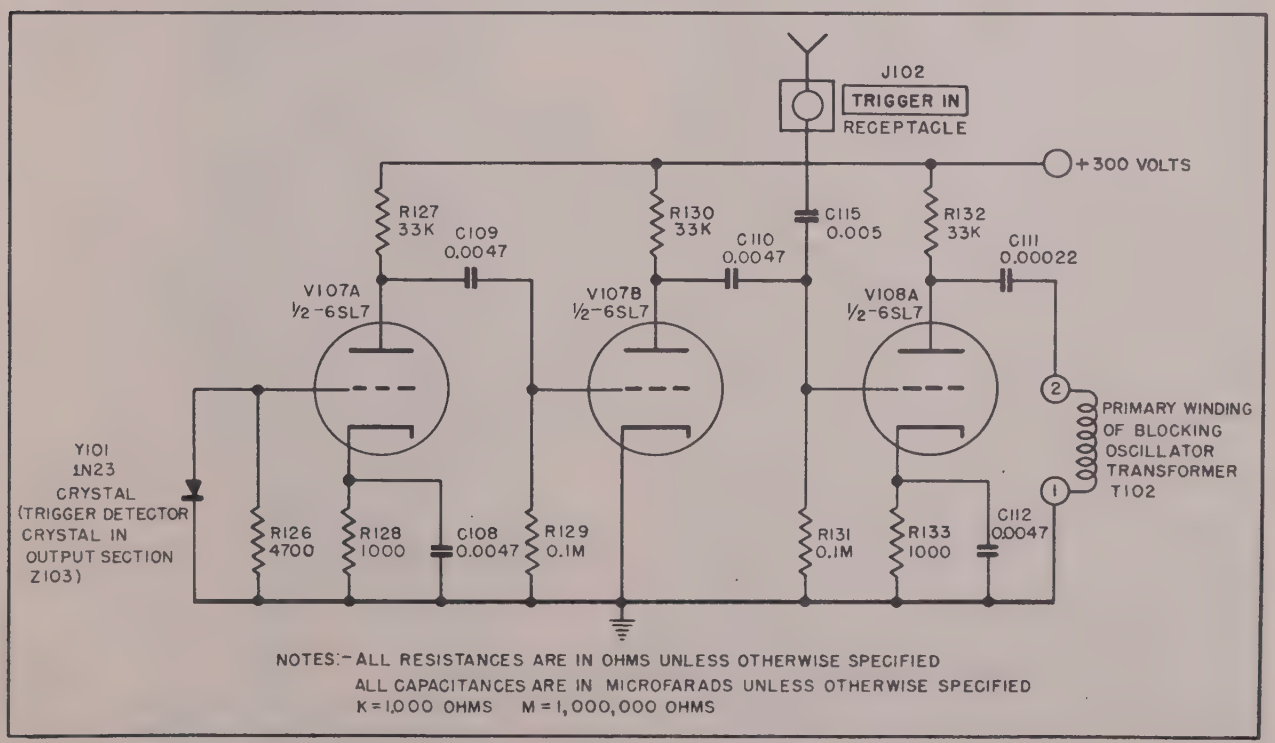


Figure 3-18. Trigger-Detector and Amplifier Circuit Simplified Schematic

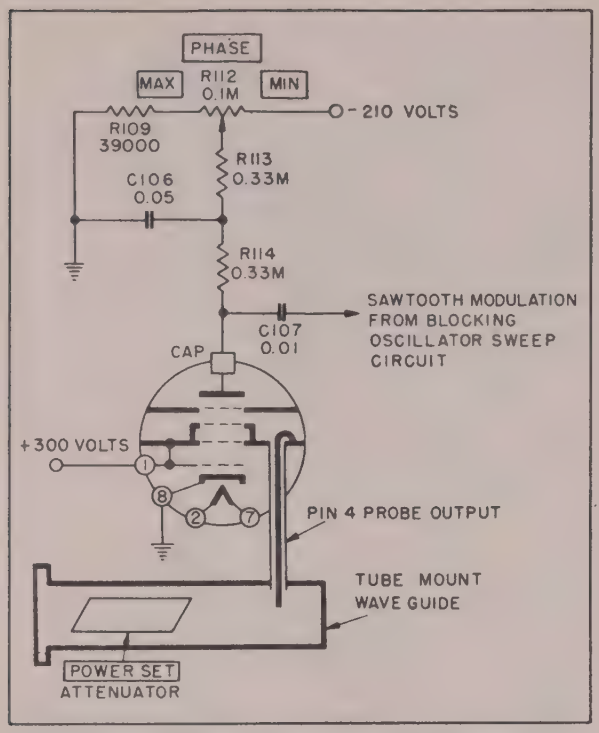


Figure 3-20. Test Oscillator Circuit Simplified Schematic

(2) The blocking oscillator generates saw tooth pulses by discharging C114. When a trigger pulse is applied to the transformer (T102), the grid is raised above cutoff and oscillation starts. The plate current which flows during the time the grid is above cutoff causes a voltage drop across the plate resistor (R136 and part of R137). This decreases the voltage across C114 to a value below the steady state voltage. When the single cycle oscillation ceases, the plate current is zero but a voltage drop still exists in the load resistor (R136) due to the charging current of C114. This voltage decreases to zero as the condenser (C114) charges to the steady state voltage. The charging curve which occurs after the oscillation ceases is the saw-tooth sweep used to modulate the test oscillator.

(3) The amplitude of the sweep voltage depends upon the steady state voltage across the condenser (C114). The voltage is made adjustable from 0 to +300v by means of the SIGNAL WIDTH potentiometer (R137). As the steady state voltage is increased by the SIGNAL WIDTH control, the amplitude of the sweep voltage is increased. The limits of the control are marked CW and MIN on the control panel. CW corresponds to zero voltage and MIN corresponds to maximum voltage. These reference marks designate the effect of the SIGNAL WIDTH control on the oscilloscope pattern obtained during receiver tests.

c. TEST OSCILLATOR CIRCUIT (figure 3-20).

(1) The test oscillator tube (V401) used in the test set is a type 2K25 reflex klystron.

(2) The reflex klystron (figure 3-21) is a velocity modulation microwave oscillator. It consists of an electron gun which produces a focused electron beam of uniform velocity, a reentrant cavity resonator tunable through the range of operating frequencies, and a reflector electrode which decelerates and returns the electron beam towards the resonator. The electrons are emitted from the cathode and are accelerated by the positive potentials on the grid and the resonator. Assuming a varying voltage on the resonator, those electrons that arrive when it is positive will be speeded up and those that arrive when it is negative will be slowed down. This results in a "bunching" of electrons into spaced groups as they proceed down the tube. Arriving near the reflector, which is maintained at a negative potential, they are repelled. If this voltage is correctly adjusted, they will be reflected back to the resonator when the voltage on it is such that the electron bunches are slowed down and so deliver energy to the resonator. Energy is taken from the tube by a coaxial probe which is terminated in the resonant cavity by a loop. When

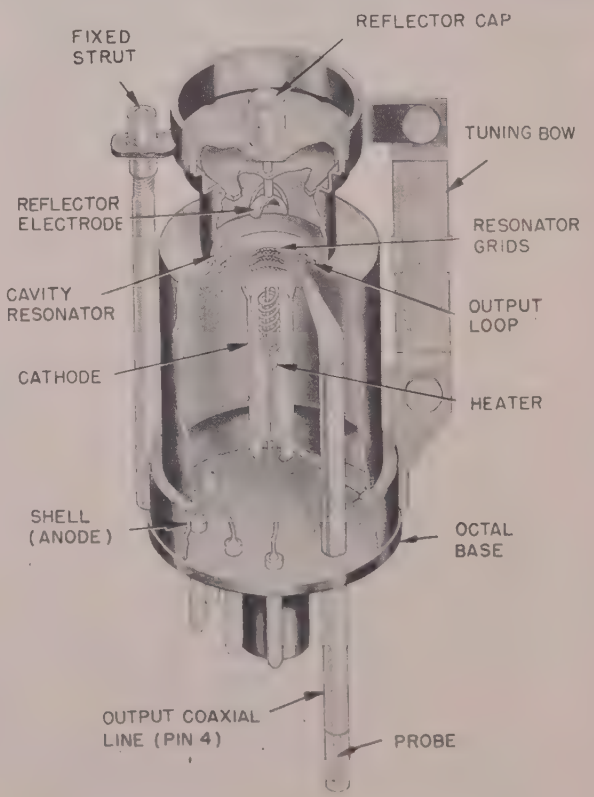


Figure 3-21. Test Oscillator Tube Cut-away View

the tube is placed in the socket of the tube mount, the coaxial probe extends into the tube mount wave guide and acts as an antenna to radiate power.

(3) There are two methods for tuning a reflex klystron tube. The tube can be tuned mechanically by varying the volume of the resonator cavity and spacing of the resonator grids. Decreasing the distance between the grids increases the capacitance of the resonant cavity, thereby decreasing the natural frequency of oscillation. This mechanical tuning is accomplished by turning the square headed nut mounted on the tube. The tuning range is covered by approximately 3½ turns of the knob and allows a variation of approximately plus or minus six percent about a specified frequency.

(4) The second method of tuning the oscillator is by varying the reflector voltage. At only one value of reflector voltage will the transit time of the electrons be correct to enable oscillation at the natural resonant frequency of the resonator cavity. If the reflector voltage is varied slightly, the rate at which electron bundles will arrive at the resonator cavity will change. The tube will not stop oscillating immediately, but will shift slightly in frequency to compensate for the change in transit time. Varying the reflector voltage thus causes the frequency of the oscillator to be swept over a range of approximately 25 to 75 megacycles.

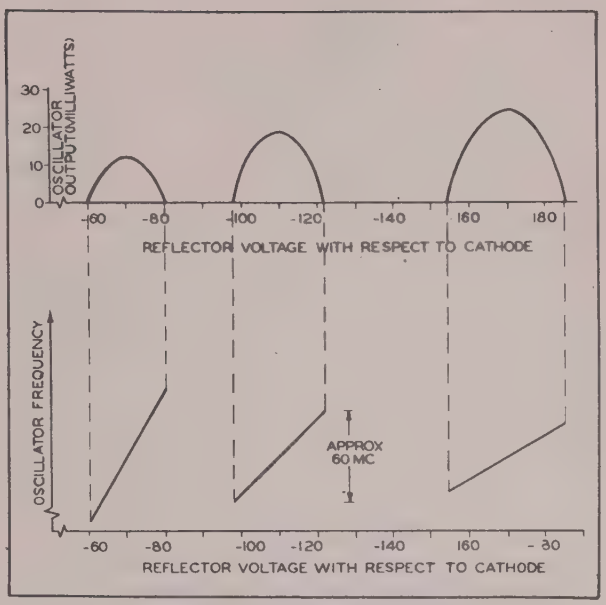


Figure 3-22. Reflex Klystron Characteristics

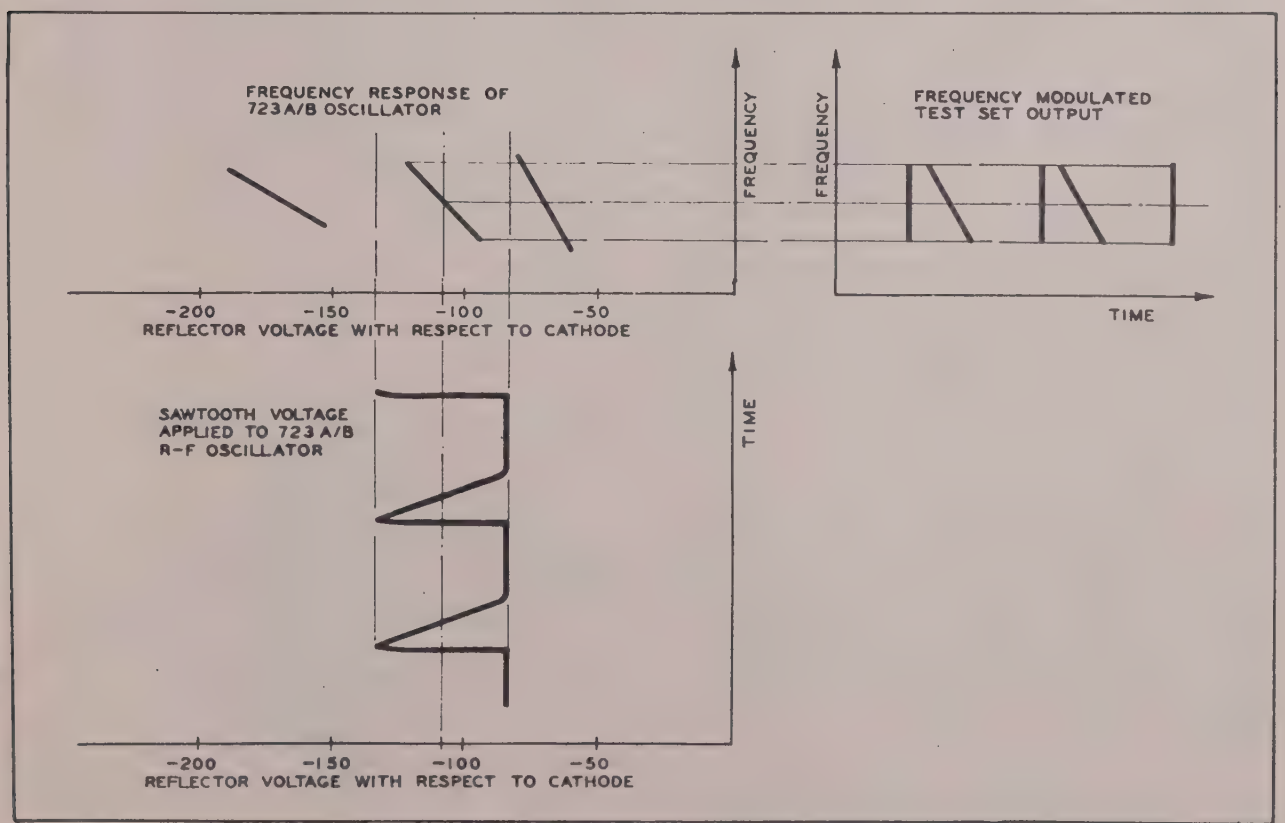


Figure 3-23. Test Oscillator Modulation

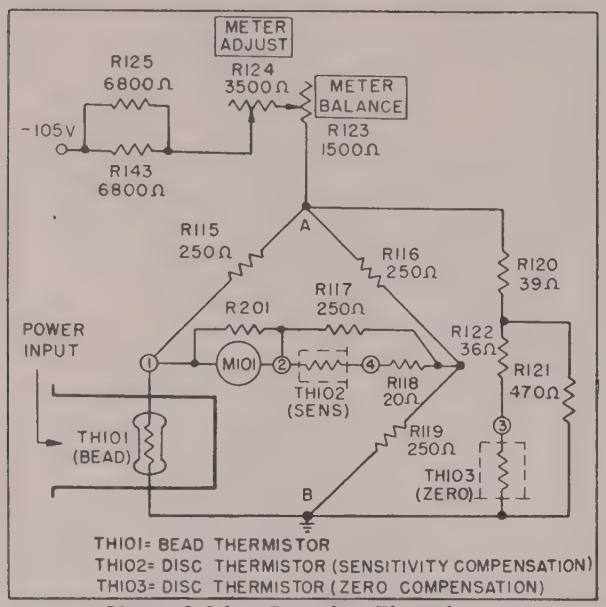


Figure 3-24. Complete Thermistor Bridge Circuit

(5) As reflector voltage is varied, the tube will oscillate in different modes, the four lowest corresponding roughly to reflector voltages of minus 30, minus 75, minus 110, and minus 170 volts with respect to the cathode. The relation of power output and frequency to reflector voltage is shown for three modes in figure 3-23. These curves are not precise for any one tube and indicate only average characteristics of the type 2K25 tube. The curves indicate that the power output of the tube is greater in the modes with more negative reflector voltages. The range of frequency sweep within each mode decreases with increasingly negative reflector voltages. Between the half power points of the minus 75-volt mode, the frequency variation is approximately 60 megacycles. In the 110-volt mode, the frequency range is approximately 35 megacycles, and in the 170-volt mode approximately 25 megacycles. Frequency data for the 30-volt mode have not been determined accurately.

(6) Figure 3-23 shows how the frequency of the test oscillator tube is modulated by varying the reflector voltage. If the saw tooth voltage is applied to the reflector about the center value of 110 volts (d-c level) as shown, the frequency of the oscillator will be swept through one or more modes and the power output will be frequency modulated. The number of modes covered depends upon the amplitude of the sawtooth. This is determined by the setting of the SIGNAL WIDTH control.

(7) When the d-c level of the sawtooth is changed to a lower voltage, the sawtooth will sweep over a lower mode. Also the time at which the center frequency of the mode is reached occurs later. Such a change appears as a shift in the position of the frequency response curve along the range axis of the A-scope. The d-c level of the sawtooth is controlled by the PHASE control.

d. THERMISTOR BRIDGE CIRCUIT (figure 3-24).

(1) GENERAL.—The thermistor bridge wattmeter is a Wheatstone bridge which measures the resistance of an r-f power sensitive resistor called a thermistor. The thermistor has a negative temperature coefficient of resistance, i.e., as the temperature is increased the resistance decreases. The temperature, and therefore the resistance, of the thermistor is determined by the temperature of its environment, by the current flowing through it, and by absorbed r-f power. If the current and ambient temperature conditions are properly controlled, r-f power can be measured by measuring the change in thermistor resistance caused by the applied power.

(2) BASIC BRIDGE CIRCUIT (figure 3-27).

(*a*) There are two types of thermistors used in the test set. The bead thermistor (see figure 3-25), used for power measurement, has a small mass and is affected by the four changes mentioned above. The disc thermistor (figure 3-26), used in compensating networks, has a large mass. Its resistance is relatively insensitive to the current flowing through it and is dependent primarily on the ambient temperature. A simplified thermistor bridge circuit is shown in figure 3-27. The Wheatstone bridge consists of three resistors (R115, R116, and R118) and the bead thermistor in the thermistor mount. When the Wheatstone bridge is balanced, no current flows in the meter. The

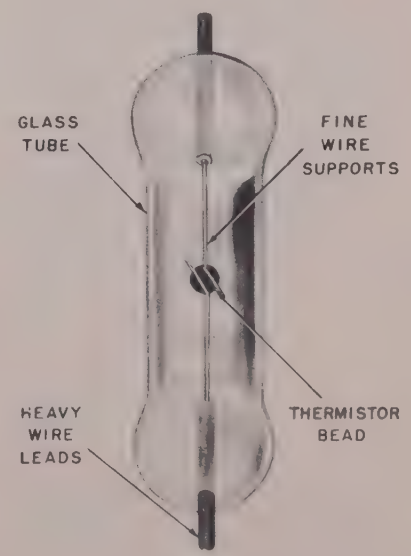


Figure 3-25. Bead Thermistor

bridge is balanced when the resistance meets the following condition:

$$\text{resistance of thermistor} = \text{R115}\frac{\text{R119}}{\text{R116}}$$

(*b*) In the test set, the bridge is designed so that it will balance when one milliwatt of r-f power is applied to the bead thermistor. This is done by adjusting the initial thermistor resistance so that, when one milliwatt of power is applied, the resistance decreases just enough to balance the bridge.

(*c*) The initial setting of the thermistor resistance is made by adjusting the current through it. This is accomplished by the METER BALANCE potentiometer (R123). The constants of the bridge are chosen so that the required initial value of thermistor resistance produces 150 μa through the meter. This current is marked BALANCE on the meter scale.

(*d*) The initial adjustment of current is referred to as "balancing" the meter because when the adjustment is made, the meter reads BALANCE. It must be realized, however, that in this condition the bridge is *unbalanced* by a known amount. Balance of the bridge is not attained until the meter current is reduced to zero by applying one milliwatt of power to the bead thermistor. The zero current point on the meter scale is marked SET POWER.

(*e*) This basic thermistor bridge circuit, shown in figure 3-27, must be modified in practical operation to overcome two disadvantages. Means are employed to compensate for the fact that the meter sensitivity (microamperes of meter current per milliwatt of r-f power) varies with temperature and that because of changes in the bead thermistor ambient temperature, the METER BALANCE control must be readjusted before every measurement. The methods employed to compensate for these disadvantages are outlined below.

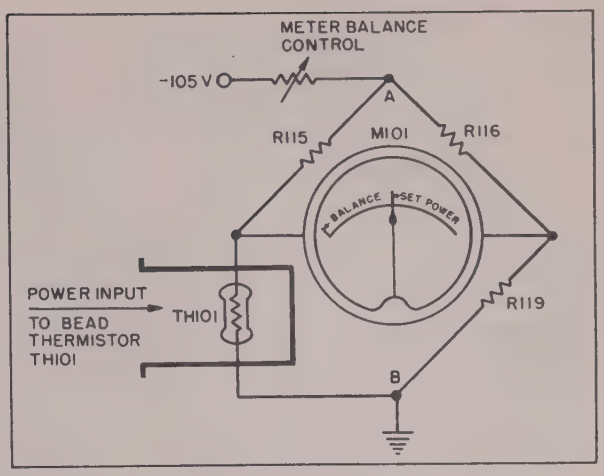


Figure 3-27. Basic Thermistor Bridge Circuit

(3) SENSITIVITY COMPENSATION (figure 3-28).

(*a*) The thermistor bridge shown in figure 3-27 increases in sensitivity with decrease in temperature. The sensitivity (ohms/watt) of the thermistor bead remains constant over a broad temperature range, but the bridge sensitivity (microamperes meter reading per milliwatts r-f power) increases with decrease in temperature. As the temperature goes down, the thermistor resistance tends to go up, making it necessary to apply a higher voltage to the bridge by adjusting the METER BALANCE control (R123). Because of this higher voltage, the change in the current through the meter, due to a given change in thermistor resistance, is greater at lower temperature.

(*b*) This variation in sensitivity can be compensated for by increasing the meter resistance as the temperature decreases. Since thermistors have this characteristic of increase in resistance with decrease

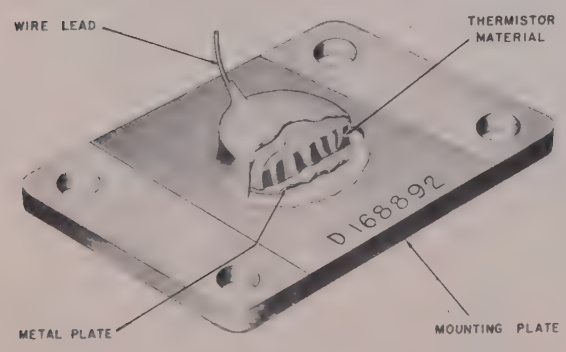


Figure 3-26. Disc Thermistor

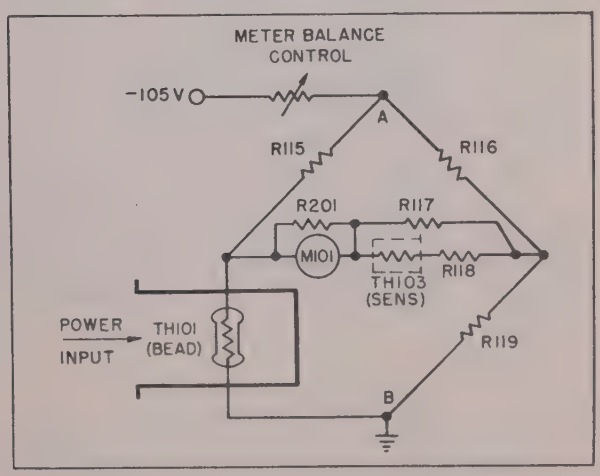


Figure 3-28. Basic Thermistor Bridge Circuit with Sensitivity Compensation

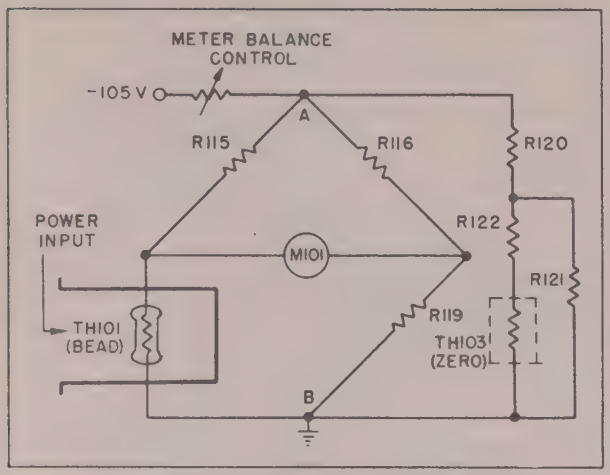


Figure 3-29. Basic Thermistor Bridge Circuit with Zero Compensation

in temperature, a disc thermistor is placed in series with the meter. (See figure 3-28.) It is necessary to put resistance R118 in series and resistance R117 in parallel with the disc thermistor to obtain the correct rate of change of resistance with temperature so that the sensitivity of the bridge remains constant over the required temperature range.

(4) ZERO DRIFT COMPENSATION (figure 3-29).

(*a*) To eliminate frequent resetting of the METER BALANCE control, an automatic method is provided for increasing the current through the bead thermistor with decrease in temperature. A disc thermistor whose resistance increases with decreasing temperature is placed in parallel with the bridge. (See figure 3-29.) Since more current flows through the bridge at lower temperature, the ratio of the resistance of the shunting disc thermistor to the resistance of the bridge (across points A and B) is greater at lower temperature.

(*b*) To adjust this compensation to cover the required temperature range, the disc thermistor is combined in a network with resistances R120, R121, and R122.

(5) COMPENSATED BRIDGE CIRCUIT (figure 3-24).

(*a*) The thermistor bridge used in the test set has both sensitivity compensation and zero drift compensation.

(*b*) Resistance, R124 (METER ADJUST), is added in series with the METER BALANCE potentiometer (R123) to adjust the range of METER BALANCE control to suit the particular thermistor mount in the test set.

(*c*) The compensating networks are designed for an average bead thermistor so that the compensation is correct at 0°C, 30°C, and 60°C. At intermediate points, the compensation is not exact although it is satisfactory for practical use. These networks are not perfect for any bead thermistor due to the variation in electrical characteristics of bead thermistors. As a result, the manual METER BALANCE control cannot be eliminated entirely.

e. POWER SUPPLY CIRCUIT.

(1) The power supply provides +300 volts and —210 volts to the electrical circuits of the test set. The power supply consists of a full wave rectifier V101, an electronic regulator, and a V-R tube regulator. The rectifier supplies about 550 volts d-c ungrounded, through a choke input L-filter. The two regulators act as a voltage divider, the center tap of which is grounded. The electronic regulator on the positive side of ground regulates and filters the +300 volt supply. The V-R tube regulator on the negative side of ground regulates the —210 volt supply and provides negative bias for the amplifier tube in the electronic regulator.

(2) The electronic regulator consists of a regulator tube (V102) which controls the output voltage directly, and an amplifier tube (V103) which controls the grid voltage on the regulator tube. The amplifier tube (V103) is connected as a d-c amplifier to amplify any voltage variations in the regulator output. The amplified variations when applied to the control grid of the regulator tube (V102) cause the regulator tube to change its voltage drop in a direction which compensates for the variations.

(3) The V-R tube regulator consists of two OC3/VR105 tubes (V105 and V106) in series. In normal operation each tube maintains a constant voltage drop of 105 volts so that the total voltage across the two in series is 210 volts. The 105-volt drop across V105 is used to supply the thermistor bridge circuit. The total voltage (210V) of the two tubes froms the d-c reflector voltage supply for the test oscillator tube (V104).

SECTION IV
MAINTENANCE

1. GENERAL.

a. Because the test set is a calibrated measuring instrument, field maintenance of the test set is necessarily limited to trouble shooting in the electrical circuits and to replacement of complete assemblies in the plumbing. At all times, field maintenance personnel must take care to avoid disturbing the fixed adjustments on any calibrated assembly. If calibration of any part is changed, then the only practical field procedure is to replace the entire assembly with a factory calibrated unit.

b. General inspection and test of the set can be performed by following the check described in paragraph 3 of section II. The performance characteristics of the test set, stated in paragraph 7 of section I, show quantitatively how the test set operates when in normal condition.

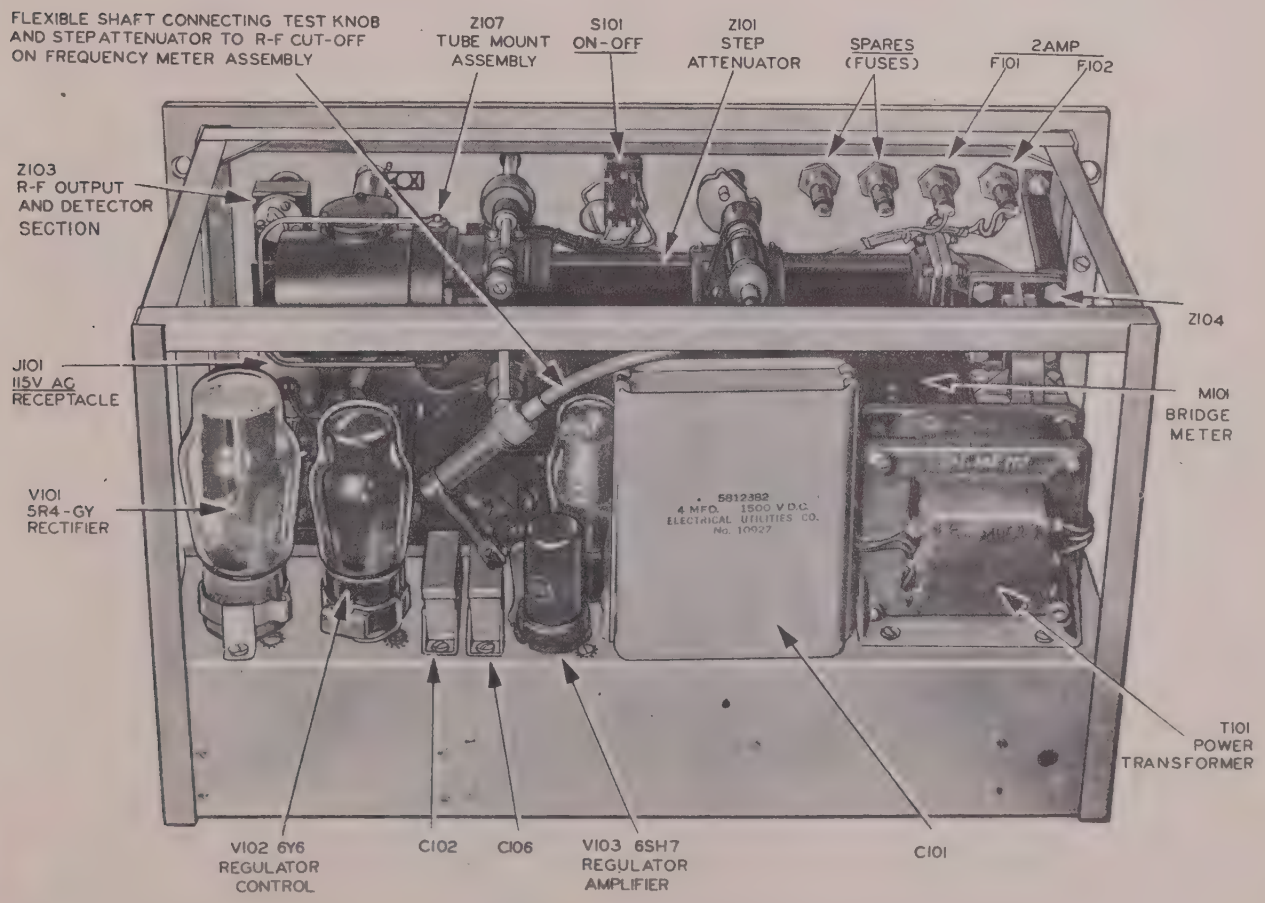


Figure 4-1. Test Set Chassis

2. DISASSEMBLY.

a. The mechanical break down of the test set is shown by the following outline.

(1) Test Set TS-147A/UP.
  (*a*) Cover
  (*b*) Test Set Unit.
    1. Cabinet
    2. Chassis Assembly
      a. Control Panel
        (*1*) Plumbing Components
      b. Power Supply Chassis
        (*1*) Amplifier Unit

b. REMOVAL OF CHASSIS ASSEMBLY FROM CABINET.

(1) Loosen the four fasteners which attach the control panel to the cabinet. These fasteners are marked A in figures 4-1 and 4-3.

(2) Carefully slide the chassis assembly out of the cabinet. Avoid bumping components against the flange in the top of the cabinet.

c. ACCESS TO AMPLIFIER UNIT.—Parts inside of the amplifier unit are accessible through an opening in the right end of the chassis.

d. REMOVAL OF AMPLIFIER UNIT FROM POWER SUPPLY CHASSIS.

(1) Remove the four amplifier mounting screws marked D in figures 4-2.

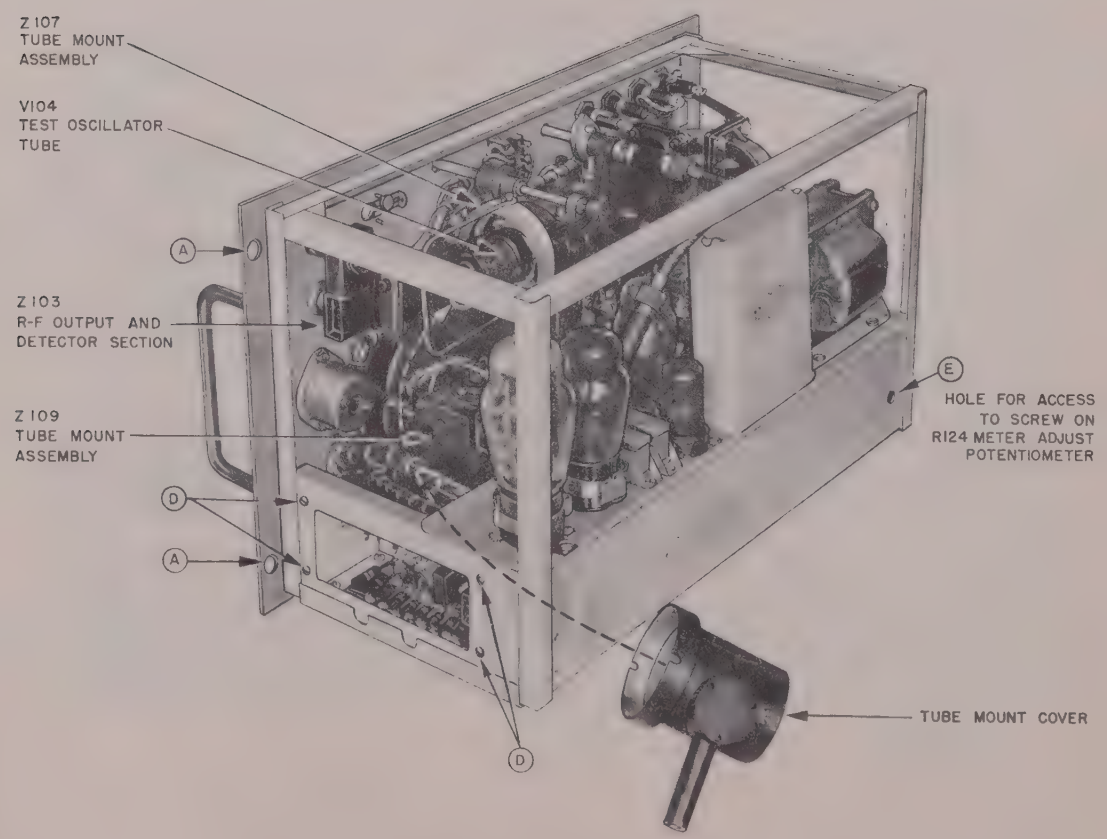


Figure 4-2. Test Set Chassis Right-end View

(2) The unit can now be moved away from the chassis for repair. If it is desirable to remove the unit entirely, unsolder the five wires which connect to the small square terminal board on the amplifier.

3. PART REPLACEMENT BY OPERATING SPARES SUPPLIED IN TEST SET.

a. GENERAL.—Parts of the test set which can be most easily damaged are supplied in duplicate in the operating spares contained in the test set. The complete set of spares supplied with each test set is listed in paragraph I.4.*f*. The following replacements can be made by operating personnel.

Note

All spares for overseas shipment are packed in moisture-proofed bags and do not appear as shown in the illustrations.

b. GASKETS.—Nine gaskets for use in wave guide gasket-flange joints are supplied in the operating spares. These gaskets are to be used as replacements whenever gaskets are found corroded or are damaged in disassembly of the plumbing system.

c. THERMISTOR MOUNT MX-435/UP.—One calibrated thermistor mount (figures 3-10, 4-3, and 4-4) complete with bead and disc thermistors is supplied with each test set. The new thermistor mount is installed by the following method:

(1) Remove the four screws and lock nuts which fasten the thermistor mount flange to the frequency meter flange.

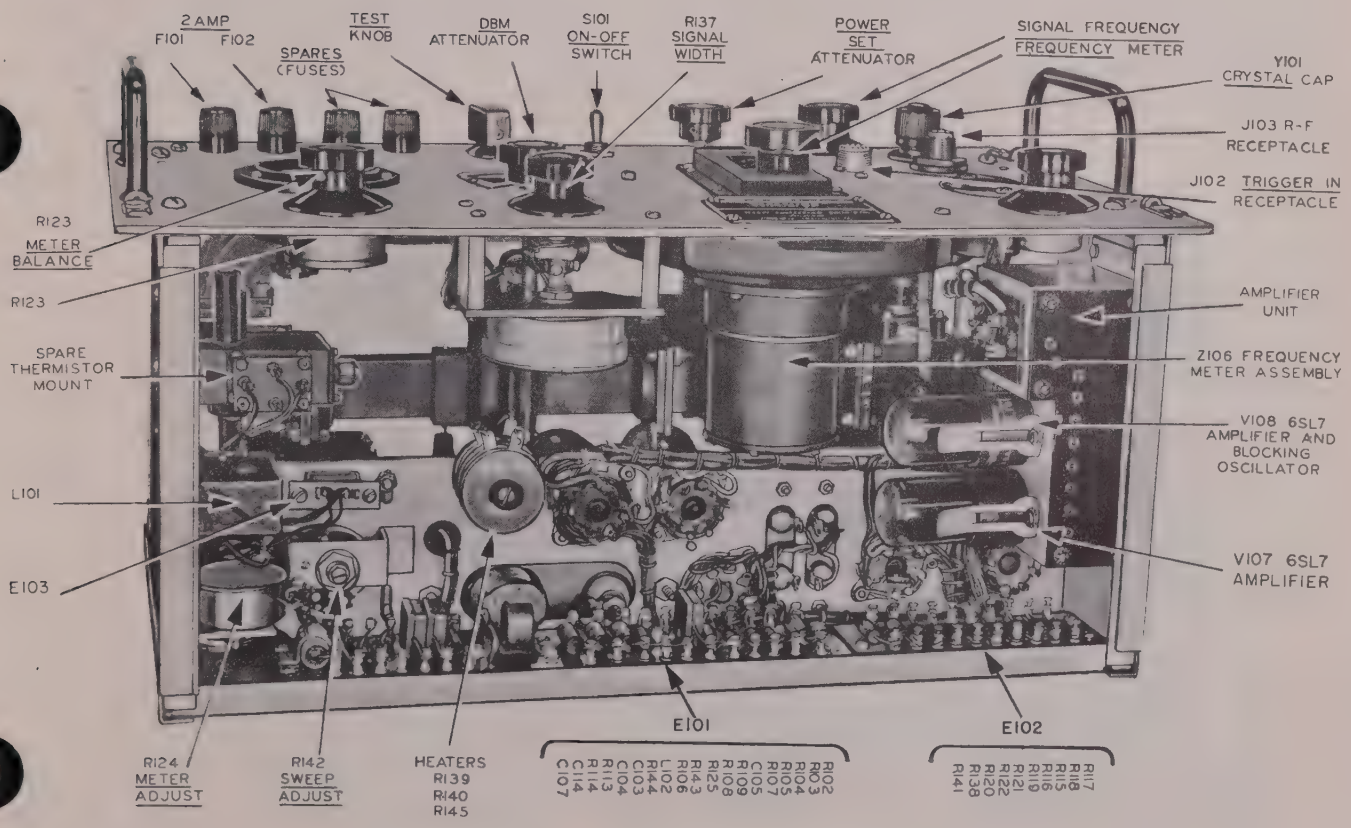


Figure 4-3. Test Set Chassis Bottom-Front View

(2) Withdraw the thermistor mount from the chassis.

(3) Unsolder the six chassis wires which connect to the four terminals on one side of the attenuator mount.

(4) Remove the four screws which attach the spare thermistor mount inside the left end of the chassis.

(5) Solder to the thermistor mount the six wires removed in step (3). See the wiring diagram, figure 7-2, for color coding.

(6) Place a new gasket against the flange of the new mount and bolt to the fixed attenuator. See that the gasket is oriented properly with respect to the wave guide length and width. The hole in the gasket should coincide with the opening of the wave guide. Be sure to replace the new mount in the same position as the old one. See figure 4-2 for proper orientation.

d. FUSES.—Five spare fuses are supplied to replace the two fuses in the primary circuit of the power transformer. For immediate use, two of the spares are contained in the holders marked SPARES on the front panel.

e. CRYSTALS.—Two Navy type 1N23 silicon rectifier crystals are supplied to replace the trigger detector crystal in the RF output section. The detector crystal is replaced by removing the knurled cap marked CRYSTAL on the control panel and inserting a new crystal cartridge into the cap.

f. LAMPS.—Three 3.0-volt panel lamps are supplied to replace the lamps used to illuminate the dials on the control panel. The dial lamps in use are removable from the front of the control panel. See figure 4-3.

4. TUBE REPLACEMENTS.

Note

All tubes of a given type supplied with the equipment shall be consumed prior to employment of tubes from general stock.

a. With one exception (V104), all tubes are easily accessible and can be removed and replaced in the ordinary manner. The rectifier tube, V101, and the regulator control tube, V102, are held in place by clamps which buckle around the bases of the tubes.

b. REPLACEMENT OF TEST OSCILLATOR TUBE, V104. (See figures 3-7 and 4-2.)

(1) Disengage the snap-slide that secures the SIGNAL FREQ. knob shaft (figure 4-5).

(2) Pull the SIGNAL FREQ. knob shaft completely out.

(3) Remove the cover of the tube mount assembly

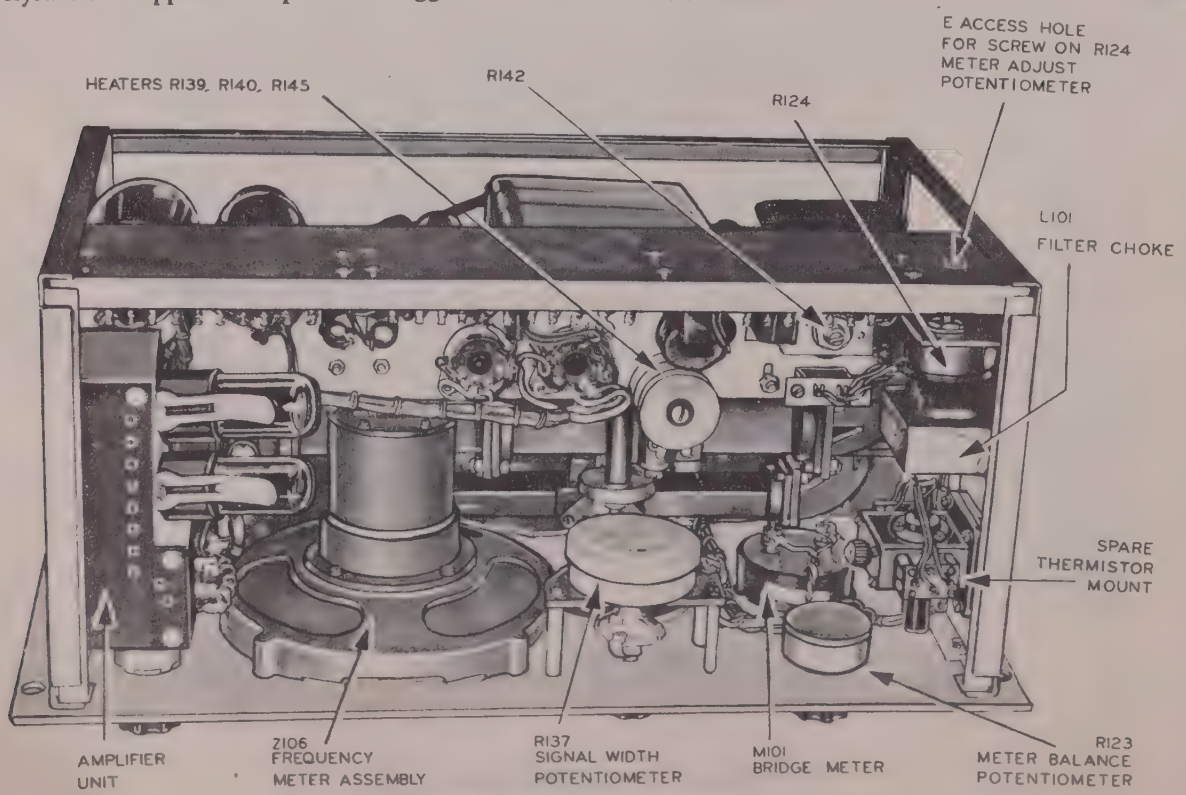


Figure 4-4. Test Set Chassis Bottom-Rear View

after releasing the snap-wire.

(4) Disconnect the cap of the oscillator tube.

(5) Push the tube clamp away from the tube and carefully pull the oscillator tube from its socket.

(6) Insert a new tube into the socket. The output probe of the tube fits into the enlarged pin hole (pin 4) in the socket. See that the tube is pressed all the way into the socket.

(7) Replace the tube cap connection.

(8) Replace the cover of the tube mount assembly.

(9) Push in the SIGNAL FREQ. knob with a twisting motion until the shaft coupling engages the tuning nut on the tube.

(10) Re-engage the snap-slide to secure the SIGNAL FREQ. knob shaft (figure 4-5).

5. ADJUSTMENTS.

a. GENERAL.—The test set contains only two adjustments which can be made by operating personnel without danger of changing the test set calibration. No other adjustments should be attempted in the field. For method of recalibrating the test set, see paragraph V.—.

b. METER ADJUST POTENTIOMETER, R124.—The purpose of this adjustment is to set the range of the METER BALANCE control so that meter balance can always be attained. The adjustment is accessible through the hole marked E in figures 4-2 and 4-4.

(1) Turn on the test set and allow about five minutes for warm up.

(2) Set the TEST knob to TRAN.

(3) Set the METER BALANCE control in the middle of its range (white index mark up).

(4) With a screw driver, adjust the METER ADJUST potentiometer until the meter reads BALANCE.

c. SWEEP ADJUST POTENTIOMETER, R142.—The purpose of potentiometer R142 is to adjust the linearity, slope, and peak of the sawtooth sweep for the oscillator tube. The adjustment is accessible through the hole marked F in figures 4-2 and 4-4.

(1) Connect an oscilloscope to the reflector of V104. Trigger both the test set and the start-stop sweep of the oscilloscope together with a suitable trigger source.

(2) Turn on the test set and allow a few minutes for warm up.

(3) Set the SIGNAL WIDTH control to MIN and the PHASE control to MAX.

(4) With a screw driver, set the SWEEP ADJUST potentiometer so that the sawtooth reaches —100 volts at 50μs. This setting should produce the most linear sweep obtainable.

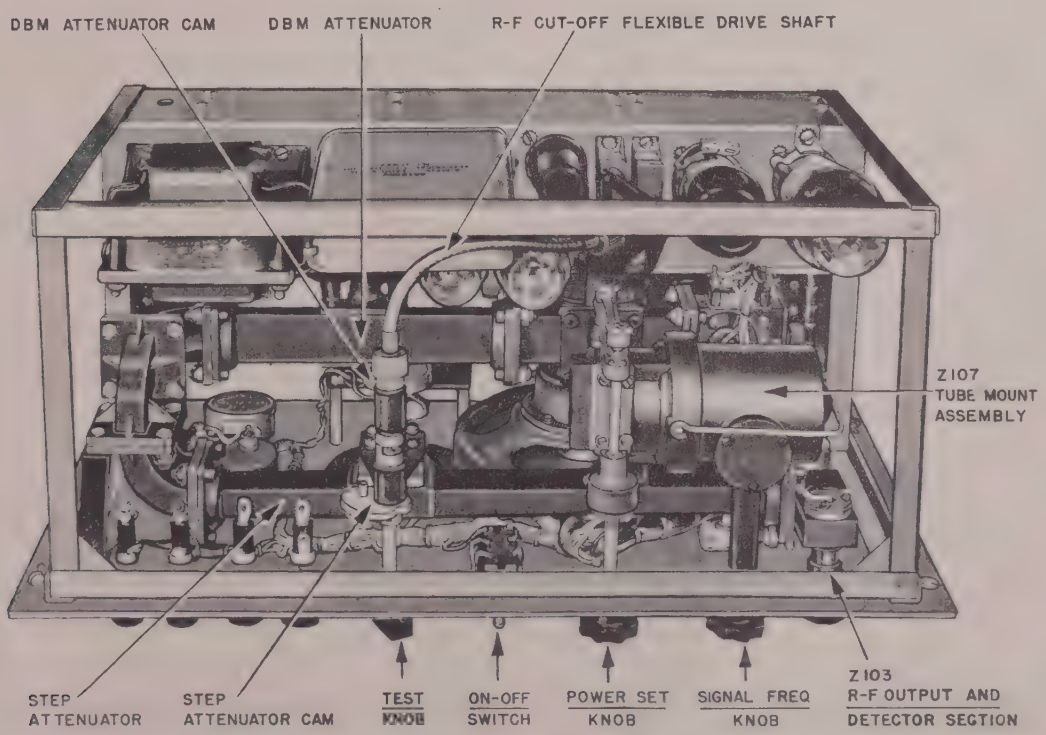


Figure 4-5. Test Set Chassis
Top-Rear View

6. VOLTAGE MEASUREMENTS.

The voltage measurements listed in the following table are made with the test set operating from a power source of 115 volts ±10%, 50 to 1600 cycles. The data compiled in the table was measured by a 20,000 ohm-per-volt meter.

Component	*Terminal*[1]	*Voltage (1000Ω/volt meter)*	*Voltage (20,000Ω/volt meter)*	*Scale*
V102 (6Y6)	8	299	303	1000
V103 (6SH7)	4	—2.2	—5	10
	6	125	160	250
	8	165	248	250
V104	1	299	303	1000
V105 (OC3)	5 to 2	—105	—105	250
V106 (OC3)	5 to 2	—105	—105	250
V107	2	214	240	250
	3	1.5	1.7	2.5
	5	175	185	250
V108	2	215	235	250
	3	1.6	1.8	2.5
	5	139	200	250
	6	18	20	250
Z109	1[2]	1.8	—1.8	10
Junction of R115, R116, R120[2]		—3.5	—3.6	10
Junction of R116, R117, R119[2]		—1.8	—1.8	10
Junction of R120, R121, R122[2]		—3.1	—3.1	10

[1] Unless two terminals are listed, voltage is measured to ground.
[2] Meter balanced, no r-f power at thermistor.

7. CURRENT MEASUREMENTS.

a. Bridge current (through R123) ..... 21 ma
b. Amplifier current (terminal 1) ..... 18 ma
c. Oscillator (V104) current (terminal 4, Z107) ..... 16 to 32 ma

8. RESISTANCE MEASUREMENTS.

The resistance measurements listed in the following table are made with the test set turned off and the power cable disconnected from the power source. Measurements on the thermistor mount Z109 may vary as much as 25 percent from the values listed, because of variations in bead thermistors.

Component	*Terminal*[1]	*Resistance*[2]
V102	3	135 K
	8	28 K
V103	4	150 K
	6	85 K
	8	2.2 M
V105	2	4500
V106	2	7900
V107	1	1840
V108	5	100 K
	6	6700
L101	1	135 K
	1 to 2	310
T101	1 to 2	3.2
	7 to 8	700
	8 to 9	700
T102	3	100 K
	1 to 2	2.3
	3 to 4	2.22
	5 to 6	12.5
Z107	1	620 K
Z109[3]	1	260
	2	250
	3	190
	4	180

NOTES

[1] Unless two terminals are listed, resistance is measured to ground.
[2] Values are in ohms except where K and M are used. K = 1,000 ohms. M = 1,000,000 ohms.
[3] Meter (M101) disconnected.

9. TROUBLES AND REMEDIES.

a. Symptom: Meter cannot be balanced by means of METER BALANCE control.

Probable Cause	*Remedy*
(1) METER ADJUST control (R124) requires adjustment.	(1) Adjust R124 as described in paragraph IV.5.
(2) See symptoms *b, c, d, e.*	

b. Symptom: Meter off scale to right.

Probable Cause	*Remedy*
(1) Short circuit across bead thermistor in Z109.	(1) Replace Z109 as described in paragraph IV. 3.*e.*

c. Symptom: Meter off scale to left.

Probable Cause	*Remedy*
(1) Open bead thermistor in Z109.	(1) Replace Z109 as described in paragraph IV. 3.*e.*
(2) See symptom *d.*	

d. Symptom:

(1) Meter off scale to left.
(2) V-R tubes, V105 and V106, glowing very bright.
(3) F101 or F102 overloaded.

Probable Cause	*Remedy*
(1) Any short circuit from +300-volt supply to ground.	(1) Remove short circuit. (*a*) Check polyiron terminal block in tube mount (Z107) for voltage breakdown.

e. Symptom:

(1) Meter reads SET POWER (zero current).
(2) Bridge circuit inoperative.
(3) Control grid of V103 glowing.
(4) V102 overheating.

Probable Cause	*Remedy*
(1) Any short circuit from —210-volt supply to ground.	(1) Remove short circuit.

f. Symptom: One dial lamp out, other lamp lit brightly.

Probable Cause	*Remedy*
(1) Either I101 or I102 is burned out.	(1) Replace burned out dial lamp.

g. Symptom: No test signal output indication on bridge meter.

Probable Cause	*Remedy*
(1) Defective test oscillator tube (V104).	(1) Replace V104 as described in paragraph IV. 4.*b.*
(2) R-f cut-off jammed.	(2) Check cut-off mechanism and flexible shaft.
(3) Bridge circuit inoperative.	(3) See symptom *e.*

h. Symptom: Test signal power output cannot be controlled by POWER SET knob.

Probable Cause	*Remedy*
(1) Broken glass strip in power-set attenuator of tube mount (Z107).	(1) Replace tube mount (Z107).

i. Symptom: No frequency modulation of test signal output.

Probable Cause	*Remedy*
(1) Sweep not being triggered by r-f input. (*a*) Transmitter output weak. (*b*) Defective crystal (Y101). (*c*) Weak amplifier tube. (*d*) Defective blocking oscillator transformer.	(1) Check amplifier and crystal (Y101). (*a*) Check transmitter output power. (*b*) Replace Y101. (*c*) Replace V107 and V108. (*d*) Replace T102.
(2) Sweep not being triggered by video trigger (IFF). (*a*) Lack of or weak trigger voltage source. (*b*) Weak amplifier tube.	(2) Check amplifier. (*a*) Check trigger source. (*b*) Replace V108.
(3) Test oscillator circuit fault.	(3) Check SIGNAL WIDTH potentiometer (R137) and capacitors C107 and C114.

j. Symptom: Test oscillator signals on A-scope appear jittery.

Probable Cause	*Remedy*
(1) Ripple present at reflector of test oscillator tube (V104).	(1) Check filter of —210-volt section of power supply.
(2) Weak triggering of sweep generator.	(2) Check crystal (Y101) and amplifier.
(3) Multiple triggering sweep generator.	(3) Check trigger source; check R134 and R135; switch radar system under test to new repetition rate.

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10. FIELD CALIBRATION OF TEST SET.

a. Compare the test set with at least two other TS-147A/UP's or similar test sets. If the test set is questionable, return the set to the nearest Electronics Officer.

SECTION V
SUPPLEMENTARY DATA

1. MEASURING PICK-UP HORN SPACE LOSS.

a. Space loss of the pick-up horn can be measured by comparison to the loss in a directional coupler. This method can be used only if a directional coupler can be installed in the type of system under test. Once the space loss for a particular type of system is determined, it is unlikely that such a measurement will have to be repeated again for each system of that type, provided that the same horn distance is always used and that the distance chosen is not critical.

b. Connect the test set as shown in figure 2-2 and follow steps (2) through (5) of paragraph 7.*b.* in section II. Record the DBM dial reading.

c. Connect the test set as shown in figure 2-3 and follow steps (2) through (5) of paragraph 7.*b.* in section II. Orient the horn for maximum DBM dial reading. Adjust the distance between the antenna and the horn until the least critical convenient distance is found. Set the power and record the DBM dial reading.

Note

The distance between the antenna and the horn should be from about three to five feet, the best distance depending upon the radar system being tested. At some distances the coupling is critical to distance, e.g., the coupling varies greatly for small changes in distance. The best position for the horn is at the distance where this effect is minimized.

d. The space loss for the horn and the particular radar system is the difference between the DBM dial readings obtained in steps *b.* and *c.* above.

e. For reference, the space loss and the distance used should be recorded in the following table.

Radar System	*D*	*H*	*Polarization*	*Space Loss*

D = Horizontal distance between antenna dipole and pick-up horn.
H = Vertical distance from line-of-sight of antenna.

2. MEASURING R-F CABLE ATTENUATION.

a. If the r-f cable becomes damaged or has been repaired, the calibration of the cable has probably changed. A new attenuation calibration can be made by the following method.

b. Connect the test set as shown in figure 2-2. Follow steps (2) through (5) of paragraph 7.*b.* in section II. Record the reading of the DBM dial.

c. Connect the unknown r-f cable in series with the cable used in step *b* by means of a UG-29B/U or a UG-30B/U connector contained in Maintenance Kit MK-47/UPM.

d. Repeat step *b.*

e. The attenuation of the unknown cable added in step *c.* is equal to the difference between the DBM dial readings obtained in steps *b.* and *d.*

3. ALTERNATE RECEIVER TUNING PROCEDURE.

This CW procedure does not require an A or J-Scope, but is not as accurate as the procedure of Section II, paragraph 6.*k*.

a. PREPARE RADAR AND TEST SET.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar	6.*a.*(1)
Prepare TS-147A/UP	6.*a.*(2)

b. ADJUST RADAR RECEIVER.—Set radar on manual tuning. Set gain high enough to show small amount of noise.

c. Set TS-147A/UP FOR RCVR TEST.—Set TEST knob to RCVR; DBM knob to about —50 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid position.

d. TUNING RECEIVER TO TRANSMITTER (OR BEACON) FREQUENCY.

(1) Set TS-147A/UP ON CW.—Turn SIGNAL WIDTH knob clockwise to CW. Maximize meter reading with PHASE control. Leave TEST on RCVR, set DBM to about —50 dbm.

(2) SET TS-147A/UP TO TRANSMITTER (OR BEACON) FREQUENCY.—Adjust SIGNAL FREQ knob to transmitter (or beacon) frequency resetting PHASE knob when meter drops 10%, checking frequency by dipping meter with FREQUENCY control.

(3) DETUNE RECEIVER LOCAL OSCILLATOR. —Set radar on manual tuning. Set local oscillator at extreme end of tuning range, but on correct side of transmitter (or beacon) frequency. Adjust local oscillator for crystal current.

(4) TUNE RECEIVER TO TS-147A/UP.—Tune receiver local oscillator mechanical tuning slowly toward center of its range, resetting the reflector voltage when crystal current drops, watching for CW signal on oscilloscope (intensified range sweep on PPI or B-scope, increased noise level on A or J-scope). See figure 5-1 for A-scope presentation. Tune mechanical tuner of receiver for maximum C-W signal, decreasing setting of DBM attenuator, if necessary, to prevent saturation.

e. ADJUST RADAR R-F COMPONENTS.—Tune TR and ATR for maximum TS-147A/UP signal. Adjust DBM attenuator to avoid flat topped signal while tuning. Adjust crystal current for proper value. Readjust L-O, TR, and ATR to compensate for interaction.

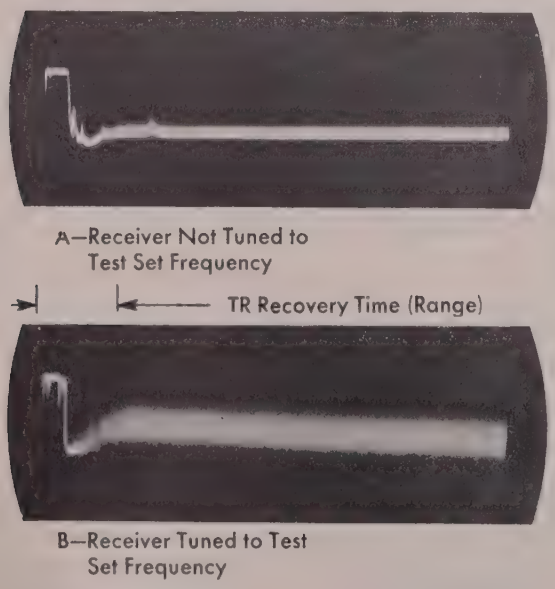


Figure 5-1. Receiver Tuning on CW and Alternate Method of Checking TR Recovery.

4. ALTERNATE TR RECOVERY CHECK.

The CW procedure is useful in special cases where the TR recovery time is short and it is not possible to phase the signal all the way into the transmitter pulse.

a. OBTAIN CW SIGNAL.—Use any of the following alternate procedures:

(1) BROADEN FM SIGNAL OUT TO CW SIGNAL.—After any of the following places: Section II, paragraphs 6.*d.*(3), 6.*d.*(4), 6.*e*, 6.*f*, 6*f.*(3), 6.*h*, 6.*i*, or 6.*k*. Detune FREQUENCY meter, turn SIGNAL WIDTH knob clockwise to CW, while holding signal in sight with PHASE knob.

(2) USE CW SIGNAL PREVIOUSLY OBTAINED.—Start after any of the folowing places:
Section II, paragraph 6.*f.*(6) or 6.*k.*(4).
Section V, paragraph 3.

b. SET SIGNAL HEIGHT (See figure 5-1 B).—Tune SIGNAL FREQ. knob for maximum height, keeping signal below saturation.

c. OBSERVE TR RECOVERY TIME.—Observe the range (time) at which the noise height (grass) starts to decrease (see figure 5-1 B).

5. MEASURING AVERAGE TRANSMITTER POWER BELOW +10 DBM.

When transmitter power entering the test set is between +1 and +10 dbm, the following procedure may be used. The regular procedure of Section II, paragraph 6.*b*. or 7.*b*. is recommended when power entering the test set is between +7 dbm and +30 dbm.

a. CONNECT TS-147A/UP TO RADAR.—Connect R-f Cable CG-92/U from RF receptacle to radar directional coupler (or test horn) as in figure 2-2 (or 2-3). Set TEST knob to TRAN and set DBM knob all the way counter-clockwise.

b. TURN ON TS-147A/UP.—Connect 115V AC receptacle to power line with Power Cord CX-377/U. Turn 115V AC switch to ON and wait two minutes.

c. BALANCE METER.—With TEST to TRAN and DBM full counter-clockwise, adjust METER BALANCE until meter is at BALANCE.

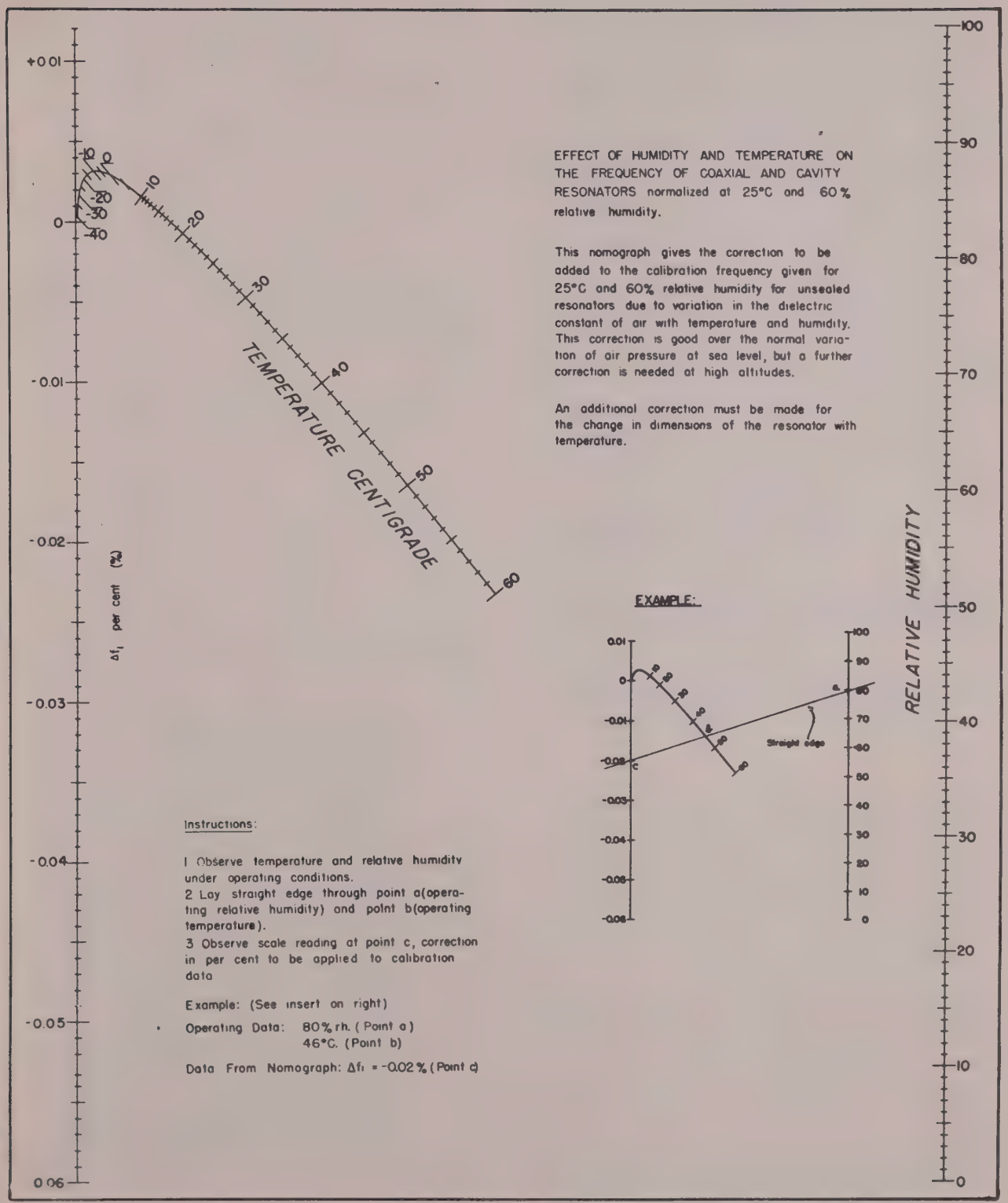

EFFECT OF HUMIDITY AND TEMPERATURE ON THE FREQUENCY OF COAXIAL AND CAVITY RESONATORS normalized at 25°C and 60% relative humidity.
This nomograph gives the correction to be added to the calibration frequency given for 25°C and 60% relative humidity for unsealed resonators due to variation in the dielectric constant of air with temperature and humidity. This correction is good over the normal variation of air pressure at sea level, but a further correction is needed at high altitudes.
An additional correction must be made for the change in dimensions of the resonator with temperature.
TEMPERATURE CENTIGRADE
RELATIVE HUMIDITY
Δf1 per cent (%)
+0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
0.06
-10
0
10
20
30
40
50
60
70
80
90
100
EXAMPLE:
Straight edge
Instructions:
1 Observe temperature and relative humidity under operating conditions.
2 Lay straight edge through point a(operating relative humidity) and point b(operating temperature).
3 Observe scale reading at point c, correction in per cent to be applied to calibration data
Example: (See insert on right)
Operating Data: 80% rh. (Point a)
46°C. (Point b)
Data From Nomograph: Δf1 = -0.02% (Point c)

Figure 5-2. Frequency Meter Corrections for Dielectric Changes Due to Temperature and Humidity

d. SET DBM DIAL.—Turn DBM dial clockwise to end of travel. Then set DBM dial carefully to +10 dbm.

e. OBSERVE POWER.—Read the meter to get power entering the test set in milliwatts. The BALANCE point is zero milliwatts, SET POWER point is 10 milliwatts, and each division represents an increase of one milliwatt.

f. CONVERT TO DBM.—Convert power entering the test set from milliwatts to dbm by use of figure 2-8.

g. COMPUTE TRANSMITTER AVERAGE POWER.—Compute as follows:

$P_{av(dbm)} = +T'_{(dbm)} + A_{(db)} + C_{(db)}$

$P_{av(dbm)}$ = Transmitter Average Power (in decibels above one milliwatt).

$T'_{(dbm)}$ = Average r-f power entering the test set (in dbm). Obtained in step *f*.

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between test set and directional coupler (or horn) in decibels. Cable loss is usually marked on cables supplied with test set.

$C_{(db)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

Example: In step *e*, meter reads 4 divisions from BALANCE point.
$T' = 4$ milliwatts.
From figure 2-8, $T' = +6$ dbm.
$P_{av(dbm)} = +6 + 4 + 20 = +30$ dbm.

6. TEMPERATURE AND HUMIDITY CORRECTIONS FOR FREQUENCY METER. (figures 5-2 and 5-3).

Note

The accurate results which the following corrections produce are seldom necessary in field use except for tuning the beacon local oscillator.

CAUTION

THE TEMPERATURE AND RELATIVE HUMIDITY SPECIFIED REFER TO THE CONDITIONS OF THE FREQUENCY METER CAVITY. THESE CONDITIONS MAY BE DIFFERENT FROM THE EXTERNAL ATMOSPHERIC CONDITION.

a. DETERMINE CORRECTION FOR DIELECTRIC CHANGE. (Use figure 5-2.)

Example: At 46°C, 80% rh, $\Delta f_1 = -0.02\%$

b. DETERMINE CORRECTION FOR DIMENSIONAL CHANGE. (Use figure 5-3.)

Example: At 46°C, $\Delta f_2 = -0.013\%$

c. COMBINE CORRECTIONS.—Add Δf_1 and Δf_2 algebraically.

Example: $\Delta f = \Delta f_1 + \Delta f_2 = -0.033\%$

d. CORRECT FREQUENCY OR DIAL READING.

(1) TO CORRECT OBSERVED FREQUENCY.—Convert Δf from percent to megacycles and add Δf (Mc) to observed frequency.

Example: $\Delta f = -0.033\%$

FREQUENCY dial reading = 938.2
observed frequency,

$f_o = 9382$ Mc

$$f = f_o + (\Delta f)\frac{f_o}{100}$$

$$f = 9382 - 0.033 \times \frac{9382}{100}$$

$f = 9382 - 3.1 = 9378.9$ mc.

(2) TO CORRECT DESIRED FREQUENCY DIAL SETTING.—Convert Δf from percent to megacycles and subtract Δf(Mc) from nominal dial reading to obtain

Example: f = Frequency desired = 9310 mc.

$\frac{f_o}{10}$ = FREQUENCY dial reading

$f_o = f - \Delta f$

$\Delta f = -3.1$ mc

$f_o = 9310 - (-3.1) = 9310 + 3.1$

$f_o = 9313.1$ Mc

$$\text{FREQUENCY dial reading} = \frac{f_o}{10} = \frac{9313}{10} = 931.3$$

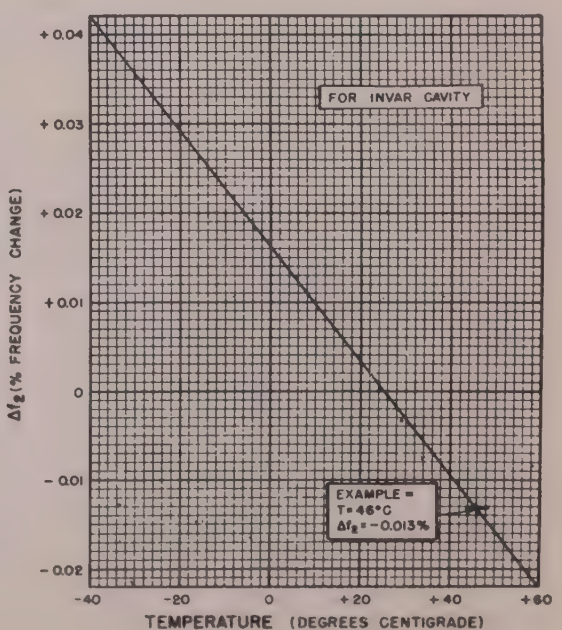


Figure 5-3. Frequency Meter Corrections for Dimensional Changes Due to Temperature.

7. MEASURING CW SIGNAL EQUAL TO NOISE.

Note

The c-w signal equal to noise is a measure of receiver sensitivity used in bench testing. It is related to, but not equal to, the receiver performance figure (minimum discernible signal power) used in field measurements.

a. CONNECT METER TO SECOND DETECTOR.—Connect a voltmeter from the cathode of the second detector tube of the radar receiver to ground.

b. CALIBRATE SECOND DETECTOR.

(1) OBTAIN CALIBRATED C-W SIGNAL.—Perform the following operation, if not already performed:

Operation	*Section-Paragraph*
Prepare Radar, Test Set and Oscilloscope	II-6.*f*.(1)
Adjust Radar Receiver	II-6.*f*.(2)
Tune Test Set to Receiver	II-6.*f*.(3)
Check Meter Balance	II-6.*f*.(4)
Find Signal Again	II-6.*f*.(5)
Set Signal Power on c-w	II-6.*f*.(6)

(2) ADJUST RECEIVER GAIN.—Turn receiver gain down and then increase gain until meter deflection starts to increase.

(3) CALIBRATE SECOND DETECTOR.—Turn DBM dial in one db steps, recording DBM dial reading and corresponding meter reading at second detector cathode. Plot DBM dial reading against meter deflection on graph paper to get calibration curve of meter reading vs. db. As an approximation, this may be assumed the constant for the same type radar.

c. SET NOISE LEVEL.—With test set DBM dial set to maximum attenuation, turn receiver gain to a convenient level (less than half of saturation) and observe second detector meter reading.

d. MEASURE C-W SIGNAL EQUAL TO NOISE.

(1) COMPUTE DESIRED METER READING.—From the calibration curve obtained in paragraph 7.*b.*(3) determine the meter reading corresponding to 3 db above the noise level reading obtained in paragraph 7.*c.*

(2) RESTORE C-W SIGNAL.—Adjust DBM dial to restore c-w signal obtained in paragraph 7.*b.*(1).

(3) SET C-W SIGNAL TO EQUAL NOISE.—Adjust DBM knob until meter reading computed in paragraph 7.*d.*(1) is obtained. Observe DBM dial reading.

(4) COMPUTE C-W SIGNAL EQUAL TO NOISE.

$$P_{new(dbm)} = (M_{(dbm)} - A_{(db)} - C_{(db)})$$

where:

$P_{new(dbm)}$ = Continuous wave power input to radar which produces power level at second detector equal to noise.

$M_{(dbm)}$ = Peak power output of the test set in dbm.

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between test set and directional coupler (or horn) in decibels.

$C_{(db)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

SECTION VI
TABLE OF REPLACEABLE PARTS

1. GENERAL.

a. All replaceable parts contained in the test set and listed in the Table of Replaceable Parts have been assigned individual reference symbol designations. The reference symbol consists of a letter of the alphabet followed by a three digit number which is the unit key number.

b. The alphabetical portion of the reference symbol was selected to facilitate cross reference of the Table of Replaceable Parts to the wiring and schematic diagrams and the list of its equivalents is found below:

C = Capacitors	S = Switches
F = Fuse	T = Transformers
I = Lamp	V = Vacuum Tubes
J = Receptacles	X = Sockets
L = Chokes	Y = Crystals
M = Meters	Z = Attenuator, Wave Meter,
R = Resistors	Tube Assy, etc.

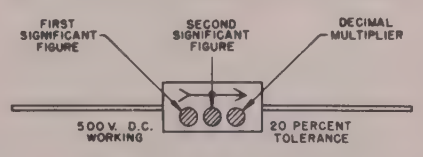
c. The reference symbol designations are obtained by combining the symbol letters with the unit key numbers, as R101, R102, etc.

d. In instances where the part is a standard part manufactured in accordance with American War Standards, the AWS type number or specification number is furnished in lieu of any other information. In cases where there is no American War Standards type or specification, the manufacturer's name and type number or contractor's drawing number are given. A list of the names and addresses of the manufacturers and their designation symbols is given at the end of the table of replaceable parts.

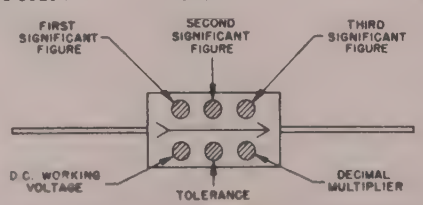
e. "Ordering of Spart Parts.—Each Service using this list has established certain depots and service groups for the storage and issue of spare parts to its organizations requiring them. The regulations of each Service should be studied to determine the method and source for requisitioning spare parts. The information in this list, as to manufacturer's or contractor's name, type, model or drawing number, is not to be interpreted as authorization to field agencies to attempt to purchase identical or comparable spare parts direct from the manufacturer or a wholesale or retail store except under emergency conditions as covered by existing regulations of the Service concerned.

2. COLOR CODES FOR CAPACITORS AND RESISTORS.

RMA COLOR CODES FOR CAPACITORS (MMFD)



COLOR	NUMERAL	VOLTS	MULTIPLIER	TOLERANCE
BLACK	0		1	
BROWN	1	100	10	1%
RED	2	200	100	2%
ORANGE	3	300	1,000	3%
YELLOW	4	400	10,000	4%
GREEN	5	500	100,000	5%
BLUE	6	600	1,000,000	6%
VIOLET	7	700	10,000,000	7%
GRAY	8	800	100,000,000	8%
WHITE	9	900	1,000,000,000	9%
GOLD		1000	0.1	5%
SILVER		2000	0.01	10%
NO COLOR		500		20%

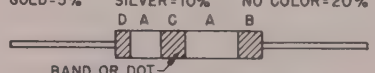


RMA COLOR CODE FOR RESISTORS (OHMS)

COLOR	A 1ST DIGIT	B 2ND DIGIT	C MULTIPLIER
SILVER			0.01
GOLD			0.1
BLACK		0	1.0
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
PURPLE	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	

D-TOLERANCE CODE

GOLD=5% SILVER=10% NO COLOR=20%



OLD COLOR ARRANGEMENT

NEW COLOR ARRANGEMENT

BODY COLOR (NEW COLOR ARRANGEMENT ONLY) INDICATES TYPE OF RESISTOR, AS FOLLOWS:,
BLACK - COMPOSITION, NON-INSULATED
TAN, OLIVE OR WHITE - COMPOSITION, INSULATED
DARK BROWN - WIRE-WOUND, INSULATED

TABLE OF REPLACEABLE PARTS

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
C–101	3300 317 643 038	CAPACITOR; Fixed: paper dielectric 4. MFD ± 10% 1500 VDCW Hermetically sealed metal can 3¾ x 1¼ x 4¾; two 10–32 x 1" Stud Term 2" C–CA top mineral oil impregnated 2 spare lug mtg brackets.	Filter	CP70E1 DH405K	46	0361
C–102	3300 316 163 390	CAPACITOR; Fixed: paper dielectric .05 MFD ± 10% 600 VDCW Hermetically sealed metal case 1¾ x 41/64 x 1½. Two soldering lug term. bottom 1" C–C mineral oil impregnated. Chanel type mounting bracket 2⅛ mtg centers.	Coupling	CP69B1E F503K	46 NHK	0362
C–103	3300 376 143 900	CAPACITOR; Fixed: Mica .01 MFD ± 10% 300 VDCW 13/16 x 13/16 x 3/16 thick. Two #18 Axial leads 1¼" long.	Filter Bypass	CM35C103K	46 1D	0363
C–104		Same as C103.	Bypass			
C–105		Same as C103.	Bypass			
C–106		Same as C102.	Bypass			
C–107	3300 317 680 913 R16 C 11252 100	CAPACITOR; Fixed: paper dielectric .01 MFD + 20% —10% 600 VDCW Hermetically sealed metal tubular case 7/16 diam. 1" long mineral oil impregated two Axial leads 1½" long.	Coupling		6 638MG	P–212 B–376 0364
C–108	3300 376 151 835	CAPACITOR; Fixed: Mica-dielectric 4700 MMF ± 10% 500 VDCW 53/64 x 53/64 x 9/32 thick. Two .040 Axial leads 1¼" long.	Coupling Bypass	CM35D 472K	6 1464T	0365
C–109		Same as C–108.	Coupling			
C–110		Same as C–108.	Coupling			
C–111	3300 376 017 410	CAPACITOR; Fixed: Silvered Mica 220 MMF ± 5% 500 VDCW 45/64 x 29/64 x 3/16 thick. Two .031 Axial leads 1¼" long.	Coupling	CM20D 221J	6 1469T	0366
C–112		Same as C–108.	Cathode Bypass			
C–113		Same as C–103.	Cathode Bypass			
C–114	3300 376 034 350	CAPACITOR; Fixed: Silvered Mica 470 MMF ± 5% 500 VDCW 11/16 x 7/16 x 3/16 thick. Two #18 Axial leads 1¼" long.	Bypass Generates Sawtooth Wave	CM20A 471J	46 5R	0367
C–115	3300 376 152 600	CAPACITOR; Fixed: Mica-dielectric 5100 MMF ± 5% 500 VDCW 53/64 x 53/64 x 9/32. Two .040 Axial leads 1¼ long.	Coupling	CM35C 512J	6 1467 LSTV	0368

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
C-116	3300 313 889 996 R16 C 9924 57 408	CAPACITOR; Silver Mica Button type 100 MMF 500 V ± 10% .447" diam. 1/16" thick.	Micro Wave Bypass		0369	9 370BA
E-101	3300 387 257 796	BOARD TERMINAL; General purpose thirty-six Cambridge Thermionic Co. #1724C turret lugs, Formica type YN-25 laminated board 9 3/16 long 1⅞ wide 3/32 thick.	General Purpose Chassis		P-212B 356	1
E-102	3300 387 257 414	BOARD TERMINAL; Chassis resistor, twenty Cambridge Thermionic Co. #1724C turret lugs, Formica type YN-25 laminated board 4⅜" long 1⅝" wide 3/32 thick.	Chassis Resistor Board		P-212A A-359	1
E-103		BOARD TERMINAL; General purpose two Cambridge Thermionic Co. #X1578C split term. lugs, Formica type YN-25 laminated board 1½" long ½" wide 3/32 thick.	Term. Board		P-212A 455	1
E-104	3300 387 257 210	BOARD TERMINAL; Amplifier resistor seventeen Cambridge Thermionic Co. #X1578C split term. lugs, Formica type YN-25 laminated board, OA 4⅝ long 2 13/16 at 1½ wide 1 13/16 at 2" wide 3/32 thick.	Amp. Resistor Board		P-212B 163	1
E-105	3300 387 256 610	BOARD TERMINAL; Amplifier general purpose, nine Cambridge Thermionic Co. #X1578C split term. lugs, Formica type YN-25 laminated board, OA 4⅝" lg. 2-13/16 at 2-13/16 wide 1-13/16 at 2" wide 3/32 thick.	Amp. General Purpose		P-212A 116	1
E-106		BOARD TERMINAL; Amplifier, five Cambridge Thermionic Co. #X1578C split term. lugs, Formica type YN-25 laminated board, 2⅛" lg. 1⅜" wd. x 3/32" thick.	Amp. Term. Board		P-212A 114	1
E-107		BOARD; Insulating, Formica YN-25, 3⅛" lg. 1½" wd. x 3/32" thick.	Insulating Board		P-212A 400	1
E-108	3300 287 641 475 R16 B 6536 10	BLOCK; Terminal: rectangular; four pollyiron and nickel plated brass term. ⅝" lg. (plus length of term.) x .810 wide x .498 high.	Attenuating Term. Block		P-212B 284	1 P-212B 284
E-109	8800 619 660	HOLDER, fuse; Extractor type for single AGC cartridge fuse ½" threaded body for panel mounting 15 AMP current rating 19/32" diam. x 1⅜" lg. solder lug term.	Hold Fuse		0670	15 HKP
E-110		Same as E-109.	Hold Fuse			

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
E–111		Same as E–109.	Hold Fuse			
E–112		Same as E–109.	Hold Fuse			
F–101	8800 356 600	FUSE; Cartridge: glass enclosed 2 AMPS 250 volt ¼" diam. x 1¼" lg.	Protective Device		15 AGC	067
F–102		Same as F–101.	Protective Device			
F–103		Same as F–101.	Spare			
F–104		Same as F–101.	Spare			
H–101	3300 651 757 916 R16 N 2175 100	NUT; Special: brass 5 8–2 4 NS–2 thd. 90° C' sunk to 41/64" diam. dimensions 1" diam. x 13/16" side diam. x ⅛" thick.	To hold Plumbing Ass'y To Panel		1	P–212A 408
H–102		WRENCH, Allen: socket, hexagonal 1-29/32" lg. with right angle elbow ¾" lg. .0937 across flats.	Tool		210	P–212A 196
H–103		WRENCH; Allen: socket, hexagonal 1-25/32 lg. with right angle elbow 25/32 lg. .0781 across flats.	Tool		210	P–212A 197
H–104	3300 287 178 460 R16 C 19700 50	CLAMP; Tube: spring steel .020 thick. L shaped long leg 1⅜" short leg ⅜" .155 diam. mounting hole.	Hold Tube		1	P–212A 105
H–105	3300 287 178 461 R16 C 19700 51	CLAMP; Tube: spring steel .020 thick L shaped long leg 1 27/32" short leg ⅜" .155 diam. mounting hole.	Hold Tube		1	P–212A 106
H–106	3300 287 172 845	CLAMP; Tube: strap and clip made of .025 bracket of .035 stainless steel. 1⅜" diam. x ¾" overall height.	Hold Tube		193 926C	0829
H–107	6600 324 379 3	GROMMET; Rubber: OD ⅝ ID ⅜ groove diam. 15/32 groove width 1/16, ⅜" thick.	Protect Wires		222 C1105	0830
I–101	8800 443 685	LAMP: Pilot, 3 volt 150 MA; grain of wheat type.	Pilot Light		88 323	094
I–102		Same as I–101.	Pilot Light			
J–101	8850 017 400	RECEPTACLE; Motor plug: male parallel blades 15 amps. 125 volts 1⅜" diam. mounting hole. Two .136 screw mounting holes 1¾" centers OA dimensions 2.031 x 1.062 deep .406 cord hole.	Power Input Recep.		18 6808	1040
J–102	8850 667 760	JACK; Female: thread size ⅝–24 polystyrene insulation 1" sq. mounting plate; four 3/32 mounting holes ¾" centers. OA dimensions 1" x 1" x 1".	Trigger Input Recep.	49194	14 49194	104

TABLE OF REPLACEABLE PARTS—Continued

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
L–101	3300 308 034 039 R16 R 1643 8	CHOKE; Reactor: consists of coil with terminals 1 & 2; 8 hy not to exceed 45 MA. OA dimensions 2⅞" x 1⅞" x 1¾" high, four ⅛" mounting holes 2 7/16" x 1 7/16" centers.	Filter		52 7X7	P–212B 23
L–102	3300 308 034 040 R16 R 1642 5	REACTOR; Consists of core (Westinghouse 1317996) Bracket (G. C. Co. P–212–A128) Banding Stap. .006 x 3/16" x 5" lg., winding (G. C. Co. P–212–A30) Inductance to be 5.5 hy + 20% —10% with no DC and 10V AC 1000 ohm applied DC resistance from term to be 227 ohms ± 10% impregnated with fosterite protecting term. and surfaces OA dim. 1⅝" x 1½" x 1-5/16" high. Two ⅛" mounting holes 1⅛" centers.	Sweep Reactor		52 7X8	P–212B 22
M–101	3300 325 226 087 R16 M 1919 20	MICROAMMETER; DC, 150–0–150 Micro AMP. Round plastic flush mounting case. Barrel 2⅛" diam. ⅞" behind flanges. Flange 2½" diam. 2% accuracy of full scale deflection 75 ohm ± 1 ohm at 25° C. Special scale black on white. Three ⅛" mounting holes 1-3/16 radius 120° apart. Two stud term. 8–32 thd. ⅝" lg.	Bridge Current Indicator		103 115151	138
O–101	3300 295 559 943 R16 S 3859	SHAFT; Flexible: bronze driver dimensions 53¼" lg. x .238" diam. including cable, nut and fitting for shaft.	To Open and close Barn Door		224 P–212B 141	P–212B 141
O–102	3300 287 690 720	COUPLING; Flexible: ceramic insulation, phosphor bronze N.P. spring, four 5/32 x 6–32 steel set screws, peak flash over 3700 volts OA dim. 1-9/32 diam. inc. springs ¾" thick for ¼" shafts.	Coupling For Potentiometer and Knob		128 39002	P–212 A–401
O–103	3300 295 757 258 R16 S 6310 10	BUSHING; Polyiron, .375 diam. .125 thick.	Broad Band Washer		225 P–212A 43	P–212A 43
R–101	3300 381 168 240	RESISTOR; Fixed: composition 2.2 Meg ± 10% ½W .375 lg. .140 diam. Two .033 axial leads 1½" lg.	Coupling V103 Plate Load	RC–20BF225K	48 EB 2251	18113
R–102	3300 381 516 220	RESISTOR; Fixed: composition 100,000 ohm ± 10% 2W .688" lg. .312" diam. Two .046 axial leads 1½" lg.	Voltage Divider	RC40BF104K	48 HB 1041	18114
R–103	3300 381 168 960	RESISTOR; Fixed: composition 33,000 ohm ± 10% ½W .375" lg. .140" diam. Two .033 axial leads 1½" long.	Voltage Divider	RC20BF333K	48 EB 3331	18115

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
R–104	3300 381 167 200	RESISTOR; Fixed: composition 150,000 ohm ± 10% ½W .375" lg. .140" diam. Two .033 axial leads 1½" long.	Voltage Divider	RC20BF154K	48 EB 1541	18116
R–105		Same as R–104.	Grid Resistor			
R–106	3300 381 516 160	RESISTOR; Fixed: composition 10,000 ohm ± 10% 2W .688" lg. .312" diam. Two .046 axial leads 1½" long.	Bleeder Resistor	RC40BF103K	48 EB 1031	18117
R–107	3300 381 318 720	RESISTOR; Fixed: composition 300,000 ohm ± 5% 1W .562" lg. .225" diam. Two .041 axial leads 1½" lg.	Voltage Divider	RC30BF304J	48 GB 3345	18118
R–108	3300 381 317 860	RESISTOR; Fixed: composition 200,000 ohm ± 5% 1W .562" lg. .225" diam. Two .041 axial leads 1½" long.	Voltage Divider	RC30BF204J	48 GB 2045	18119
R–109	3300 381 169 380	RESISTOR; Fixed: composition 39,000 ohm ± 10% ½W .375" long .140" diam. Two .033 axial leads 1½" long.	Limiting Resistor	RC20BF393K	48 EB 3931	18120
R–110		Not used.				
R–111		Not used.				
R–112	3300 399 810 005 R16 P 5590 65	RESISTOR; Variable: composition 100,000 ohm ± 20% ½W 100° C max. continuous operation 3 solder lug term. enclosed metal case 1¼" diam. 9/16" depth S.S. shaft linear taper normal torque ⅜–32 bushing ⅜" long ¼" shaft ⅞" long.	2K25 Reflector Voltage Control		183 Type 35	P–212B 399
R–113	3300 381 169 020	RESISTOR; Fixed: composition 330,000 ohm ± 10% ½W .375" long .140" diam. Two .033 axial leads 1½" long.	Filter Resistor	RC20BF334K	48 EB 3341	18121
R–114		Same as R–113.	Coupling Resistor			
R–115	3300 381 162 980	RESISTOR; Fixed: composition 250 ohm ± 5% ½" wide .375" lg. .140" diam. Two .033 axial leads 1½" long.	Bridge Circuit with R116 and R117	RC21BF251J	48 EB 2515	18122
R–116		Same as R–115.	Bridge Circuit with R115 and R117			
R–117		Same as R–115.	Bridge Circuit with R115 and R116			

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
R–118	3300 381 167 780	RESISTOR; Fixed: composition 20 ohm ± 5% ½" wide .375" lg. .140" diam. Two .033 axial leads 1½" long.	Compensating Resistor	RC20B F200J	48 EB 2005	18123
R–119		Same as R–115.	Compensating Resistor			
R–120	3300 381 169 240	RESISTOR; Fixed: composition 39 ohm ± 5% ½" wide .375" lg. .140" diam. Two .033 axial leads 1½" lg.	Compensating Resistor	RC20B F390J	48 EB 3905	18124
R–121	3300 381 169 660	RESISTOR; Fixed: composition 470 ohm ± 5% ½" wide .375 long .140 diam. two .033 axial leads 1½" long.	Compensating Resistor	RC20B F471J	48 EB 4715	18125
R–122	3300 381 169 120	RESISTOR; Fixed: composition 36 ohm ± 5% ½" wide .375" lg. .140" diam. Two .033 axial leads 1½" long.	Compensating Resistor	RC20B F360J	48 EB 3605	18126
R–123	3300 380 078 130 R16 P 6893 8 915	RESISTOR; Variable: wire wound 1500 ohm ± 10% 4" wide solder lug term. enclosed metal case 1-17/32 diam. 11/16 depth linear taper normal torque ⅜–32 bushing ⅜" lg. ¼" shaft ⅞" lg.	Meter Balance Control	RA30A1 FD152K	183 Type 25	18127
R–124	3300 380 066 080 R16 P 6905 370 500	RESISTOR; Variable: wire wound 3500 ohm ± 10% 4" wide solder lug term. enclosed metal case 1-17/32 diam. 11/16 depth linear taper normal torque ⅜–32 bushing ⅜" lg. slotted shaft ⅛" lg.	Coarse Meter Balance Control	RC30A1 SA352K	183 Type 25	18128
R–125	3300 381 520 580	RESISTOR; Fixed: composition 6800 ohm ± 10% 2" wide .688 lg. .312 diam. Two .046 axial leads 1½" long.	Series Resistor	RC40B F682K	48 HB 6821	18129
R–126	3300 381 169 740	RESISTOR; Fixed: composition 4700 ohm ± 10% ½" wide .375 lg. .140 diam. Two .033 axial leads 1½" lg.	Coupling Resistor	RC20B F472K	48 EB 4721	18130
R–127		Same as R–103.	Coupling Resistor			
R–128	3300 381 166 100	RESISTOR; Fixed: composition 1000 ohm ± 10% ½W .375 long .140 diam. two .033 axial leads 1½ long.	Cathode Bias Resistor	RC20B F102K	48 EB 1021	18131
R–129	3300 381 166 220	RESISTOR; Fixed: composition 100,000 ohm ± 10% ½W .375 long .140 diam. two .033 axial leads 1½ long.	Coupling Resistor	RC20B F104K	48 EB 1041	18132
R–130	3300 381 318 960	RESISTOR; Fixed: composition 33,000 ohm ± 10% 1W .562 long .225 diam. two .041 axial leads 1½ long.	Coupling Resistor	RC30BF333K	GB 3331	18133

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
R–131		Same as R–129.	Grid Resistor			
R–132		Same as R–103.	Coupling Resistor			
R–133		Same as R–128.	Cathode Resistor			
R–134	3300 381 516 220	RESISTOR; Fixed: composition 100,000 ohm ± 10% 2W .688 long .312 diam. two .046 axial leads 1½ lg.	Voltage Divider	RC40BF104K	48 HB 1041	18134
R–135	3300 381 170 580	RESISTOR; Fixed: composition 6800 ohm ± 10% ½W .375 long .140 diam. two .033 axial leads 1½ long.	Cathode Resistor	RC20BF682K	48 EB 6821	18135
R–136		Not used.				
R–137	3300 380 084 030 R16 P 6958 750	RESISTOR; Variable: wire wound 50,000 ohm ± 10% 7W solder lug term. enclosed metal case diam. depth linear taper normal torque ⅜–32 bushing ⅜" long ¼" shaft ⅞" long.	Signal Width Control	RA40A 1FD503K		18136
R–138	3300 381 317 940	RESISTOR; Fixed: composition 22 ohm ± 10% 1W .562 long .225 diam. two .041 axial leads 1½ long.	Voltage Dropping Resistor	RC20BF220K	48 EB 2201	18137
R–139	3300 396 603 024 R16 R 18636 202	RESISTOR; Fixed: wire wound 180 ohm ± 10% 18 watts circular ceramic base 1⅜ diam. ⅜ thk. 2 solder lugs. .196 mounting hole center of base.	Heater Resistor		223 Disc ohm 18D180	18138
R–140		Same as R–139.	Heater Resistor			
R–141		Same as R–138.	Series Resistor			
R–142	3300 399 812 018 R16 P 5595 94	RESISTOR; Variable: composition 1 meg ohm ± 20% ½W. solder lug terminals enclosed metal case 1⅜ diam. .491 depth linear taper normal torque ⅜–32 bushing ⅜" long ¼ diam. S. D. shaft.	Sweep Adjust Potentiometer		183 Type 25	P–212B 375 18139
R–143		Same as R–125.	Series Resistor			
R–144		Same as R–106.	Bleeder Resistor			

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
R-145		Same as R-139	Heater			
R-146	3300 394 186 098	THERMISTOR: Metal envelope .803 ohm at 75° F (24° C) 1¼" lg. x ⅞ wd. x 5/16 high four mtg. holes .1285" diam. 1" x ⅝" mtg. centers #22 tinned copper lead 4" long extending from envelope.	Temperature Compensating Elements		55 D168392	18140
R-147	3300 394 186 070	THERMISTOR: Metal envelope 765 ohms at 75° F (24° C) 1¼ lg. ⅞ wd x 5/16 high four mtg. holes .1285 diam. on 1" x ⅝ mtg centers #22 tinned copper lead 4" lg extending from envelope.	Temperature Compensating Elements		55 D168391	18141
S-101	3300 395 739 045	SWITCH; Toggle: D.P.D.T. 125 volt 6 AMP bakelite case O.A. dimensions 1 9/32" x 23/32 x 2⅛" solder lug term. Bat handle.	Power Switch	ST22N	116 ST22	P-212B 411
T-101	3300 296 937 732	TRANSFORMER: Consists of term 1-2 (115 volts 50-1200 CPS): Term 7-8-9 (850-0-850) volts RMS at 50 Ma DC): Term. 3-4 (63 volts at 125 AMP): term 5-6 (5 volts at 2 AMPS) Term 10-11 (6.3 volts at 1-7 AMP): #20 AWS wire OA dimensions 3¾ long x 2½ wide x 3½ high four 5/32 mtg holes 2 5/16 x 2 9/16 centers.	Power Transformer		52 7K7	P-212C 20
T-102	3300 296 949 068 R16 T 6951 350	TRANSFORMER: Pulse three sectional winding inner sec. 90 turns #33 wire; middle sec. 90 turns #33 wire; outer sec. 135 turns #38 wire D.C. resis windings 1-2, 2.60 ohms ± 10%, 3-4 — 2.80 ohms ± 10% at 75° C; 5-6, 14.5 ohms ± 10% solder lug term. 1½ x 1-7/16 x 1½ high.	Pulse Transformer		52 3JL	P-212B 160
U-101	R16 A 3658	AMPLIFIER UNIT ASS'Y: Video; output driver; oscillator sweep generator 45 volts; dimensions: 2-11/16 in. wide x 2-7/16 in. high. x 5¼ in. deep (115 volts, 50-2400 cycle single phase); two input channels, one for low impedance low level IN23 crystal and one for high impedance high level for trigger; input voltage one: square pulse 0.5 micro seconds, 1000 to 3500 cycles, .05 to 5.0 volts; two: same except amplitude of from 2.0 to 150 volts; total gain 450 volts; metal cabinet.	Sawtooth Generator & Trigger Amplifier		1 P-212D 10D	P-212D 10D
V-101	3300 234 355 000	TUBE: Electron 5R4GY full wave high vacuum rectifier JAN-1A.	Power Rectifier	5R4GY	4 JAN 5R4GY	5R4GY
V-102	3300 234 820 000	TUBE: Electron 6Y6G Beam power amplifier. JAN-1A.	Voltage Regulator	6Y6G	4 JAN 6Y6G	6Y6G
V-103	3300 234 710 000	TUBE: Electron 6SH7 H-F Amplifier pentode. JAN-1A.	Regulation Amplifier	6SH7	4 JAN 6SH7	6SH7

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
V–104	3300 234 198 990	TUBE: Electron 2K25 Oscillator JAN–1A.	Oscillator	2K25	55 JAN 2K25	2K25
V–105	3300 234 006 500	TUBE: Electron OC3/VR105 Voltage regulator JAN–1A.	Voltage Regulator	OC3/VR–105	4 OC3/VR–105	OC3/VR–105
V–106		Same as V–105.	Voltage Regulator			
V–107	3300 234 750 000	TUBE: Electron 6SL7–GT; Twin Triode amplifier, JAN–1A.	Amplifier and Sawtooth	6SL7–GT	4 JAN 6SL7GT	6SL7GT
V–108		Same as V–107.				
X–101	8850 889 919	SOCKET; Tube: octal silver plated contacts cadmium plated steel mounting, dimensions 1-13/16 x 1-13/64.	Hold V–101		1 M1P8	241
X–102		Same as X–101.	Hold V–102			
X–103		Same as X–101.	Hold V–103		191 9898	P–212B 109
X–104		Not Used.				
X–105		Same as X–101.	Hold V–105			
X–106		Same as X–101.	Hold V–106			
X–107		Same as X–101.	Hold V–107			
X–108		Same as X–101.	Hold V–108			
Y–101	3300 234 137 225	CRYSTAL: Rectifier contains silicon crystals at base.	Crystal Rectifier	IN23B	IN23B	254
Z–101	1600 327 305 619 R16 AN-AT-68/UP	PICK–UP ANTENNA; Ass'y: Aluminum alloy and silver black & paladium flash 2-13/64 lg x 1-3/32 deep x 2-21/64 high. 1–probe ass'y P–212–A81, 1 bead P–212–A–77 1–probe P–212–A–79 1–2 P–212–A–80.	Pick-up	AT–68/UP	1 P–212 B–4	P–212 B–4
Z–102	1690 322 980 733	OUTPUT CABLE ASS'Y: consists of 8'–0 RG 9A/U cable, one UG–21B/U connector each end.	Output and Input Signal	92/U(8)	1 P–212 A–3–D	P–212 A–3–D

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
Z–103	3300 286 054 677 R16 T 1982	OUTPUT SECTION: Brass; silver-plated. Consists of: waveguide with projecting type-end fitting. Flanged to dual position attenuator dimensions: 2½ in. x 2 in. x 2 in.	Socket		1 P–212 B–12–D	P–212 B–12–D
Z–104	3300 291 643 468 R16 W 1802 725	WAVEGUIDE SECTION ASS'Y: Consists of gasket (G.C. Co. Dwg. P–212–A28) H–Plane bend (G.C. P–212–C–167) two E–Plane bend (G.C. P–212–C–166) OA dim. 4" x 4" x 2".	Waveguide		1 P–212 B–17	P–212 B–17
Z–105	3300 286 066 437 R16 T 1981	CALIBRATED ATTENUATOR ASS'Y: Brass consists of: Plate-guide, 4⅝ with two attaching flanges; internal mechanism contains a chemically treated moveable glass strip. Dim. 5⅝ wide x 3⅛ high x 6½ lg.	Power Control		1 P–212 C–16	P–212 C–16
Z–106	3300 328 530 244 R16 T 1980	DIAL AND WAVEMETER ASS'Y: consists of: End plate (G.C. P–212–A–82) T–Section Assy. (G.C. P–212–B–19) adapter (G.C. P–212–A–20) wavemeter dial ass'y. (G.C. P–212–C–21) approx. OA dim. 7⅞ x 6⅛ x 5⅞.	Measures Frequency		1 P–212 C–13	P–212 C–13
Z–107	3300 293 353 521 R16 T 1977	TUBE MOUNT ASS'Y: Consists of spring (G.C. Co. P–212–A243) clip (G.C. P–212–A247) terminal block (G.C. P–212–B–284) Tube cap. (G.C. 212A2–59) Spring (G.C. 212–A–252) cover ass'y (P212–B279) shaft ass'y (P212–A283) tube mount sub-ass'y (G.C. P–212–D–299) stop mechanism Ass'y (G.C. P–212–B–269) OA dim. 6-3/16" x 4" x 5".	Signal Source		1 P–212 D–14	P–212 D–14
Z–108		Not Used.				
Z–109	1690 328 824 415 R16 T 2275	THERMISTOR ASS'Y: Cast aluminum; Finish black paint. A mounting for two ambient temperature compensating thermistors, and one bead thermistor in R.F. field which varies resistance with R.F. power; Overall dimension: 3-19/32 in. x 2-31/32 in. x 2-17/32 in.	Measure Power		1 P–212 B–15	P–212 B–15
Z–110	3300 286 066 433 R16 T 1979	ATTENUATOR STEP: Dual position min-max; calibrated 40 db microwave attenuator of the parallel vane type; 11.191 in. long x 5.062 in. wide; 8 (4 each flange), .1695 in. diameter mounting holes on 1.280 in. x 1.280 in. centers.	Micro Wave Attenuator		1 P–212 D–18	P–212 D–18
Z–111	1600 322 981 795	VIDEO CABLE: Consists of 6'–0 RG–11/U cable. 1–Navy Type 49195 connector one end, 1–49195 and 1–49192–A other.	Connector 91/U(6) To test Set		1 P–212 A–5	P–212 A–5

MODEL: TEST SET TS-147A/UP

Reference Symbol	AF/NAVY STOCK NO.	NAME OF PART and DESCRIPTION	FUNCTION	AWS-JAN or Navy Type Desig.	MFR. and DESIG. or AWS TYPE	CONT. or GOVT. DWG. or SPEC. No.
Z–112	3300 322 001 039	CABLE; Power: 6'–0 Simplex Wire Co. tirex cord type SO; Hubbell #7257 female body one end Hubbell 7057 male cap other.	Connector 337/U(6) To Power Source		1 P–212 A–430	P–212 A–430
	R16 K 3345 350 3300 292 241 228	KNOB: Round; black bakelite fluted with skirt; for ¼ in. diam. shaft; single No. 8–32 x ¼ inch cup point set screw; dimensions: 1½ in. diam. x 13/16 in. thick.	Knob		200 4104	P–212 A–423
	3300 292 242 525 R16 K 3338 520	KNOB: Round; black bakelite fluted with skirt; for ¼ in. diam. shaft single No. 8–32 x 9/32 in. cup point set screw; dimensions: 1½ in. diam. x 13/16 in. thick.	Knob		200 4104D	P–212 420
	3300 292 103 080 R16 GCC 0572	KNOB: Round; fluted; black bakelite for ¼ in. diam. shaft; two .164 in. —32 allen head steel cup point set screws dimensions: 1⅜ in. diam. x 9/16 in. thick.	Knob		200 4101	0572
	3300 292 278 380 R16 GCC 0573	KNOB: Round; fluted; black bakelite for ¼ in. diam. shaft; two No. 8–32 allen head cup point set screws dimensions: 1⅛ in. diam. x ⅝ in. thick.	Knob		200 4100C	0573
	3300 218 388 000 R16 GCC 0574	KNOB: Bar; black bakelite for ¼" shaft two 6–32 cup point set screws 1¼ long ¾" wide ⅝" high.	Knob		192 HRP–P	0574
	3300 291 618 147 R16 G 2342	GASKET; Brass: 1⅝ x 1⅝ x .033 thk. I.D. .920 x .420 4–.193 holes 1.220 and 1.280 centers	Leakage protec-tion		1 P–212–A28	P–212 A–28
	3300 291 618 148 R16 G 2342-5	GASKET: Polyiron 2.525 O.D. x 2.230 I.D. x .156 thk.	Leakage protec-tion		225 P–212–A–260	P–212 A–260

4. MANUFACTURERS' NAMES, ADDRESSES, AND SYMBOLS.

CODE NO.	MFGR. PREFIX	NAME
1	CGZ	General Communication Company 681 Beacon Street Boston, Massachusetts
3	CHS	Sylvania Elec. Products Company 500 Fifth Avenue New York, New York
4	CRV	R. C. A. Victor Division 151 Westside Avenue Jersey City, New Jersey
6	CAM	Aerovox Corporation 740 Belleville Avenue New Bedford, Massachusetts
14	CPH	American Phenolic Corporation 1830 South 54th Avenue Chicago, Illinois
15	CFA	Bussman Mfg. Company University at Jefferson St. Louis, Missouri
18	CHU	Harvey Hubbell, Incorporated 447 Concord Avenue Bridgeport, Connecticut
46	CD	Cornell Dubilier 1000 Hamilton Boulevard South Plainfield, New Jersey
48	CBZ	Allen Bradley Corporation Milwaukee, Wisconsin
52	CAY	Westinghouse Elec. & Mfg. Company East Pittsburgh, Pennsylvania
55	CW	Western Electric Company 300 Central Avenue Kearney, New Jersey
88	CG	General Electric Company Schenectady, New York
103	CV	Weston Electric Inst. Company 619 Frelinghuysen Avenue Newark, New Jersey
116	CHH	Arrow-Hart & Hegeman Company 103 Hawthorne Street Hartford, Connecticut
128	CJA	James Millen Mfg. Company 150 Exchange Street Malden, Massachusetts
183	CTC	Chicago Telephone Supply Company Elkhart, Indiana
191	CMG	Cinch Mfg. Company 2339 West Van Buren Street Chicago, Illinois
192	CNA	The National Company 61 Sherman Street Malden, Massachusetts
193	CAIS	The Birtcher Corporation 5087 Huntington Drive Los Angeles, California
200		Harry Davies Moulding Co. 1428 North Wells Street Chicago, Illinois
210	CAYT	Allen Mfg. Company Hartford, Connecticut
222		Western Rubber Company Goshen, Indiana
223	CAO	Ward Leonard Company 6 South Street Mt. Vernon, New York
224	CA	S. S. White Dental Company 10 East 46th Street New York, New York
225	CCJ	Henry L. Crowley Company 3 Central Avenue West Orange, New Jersey

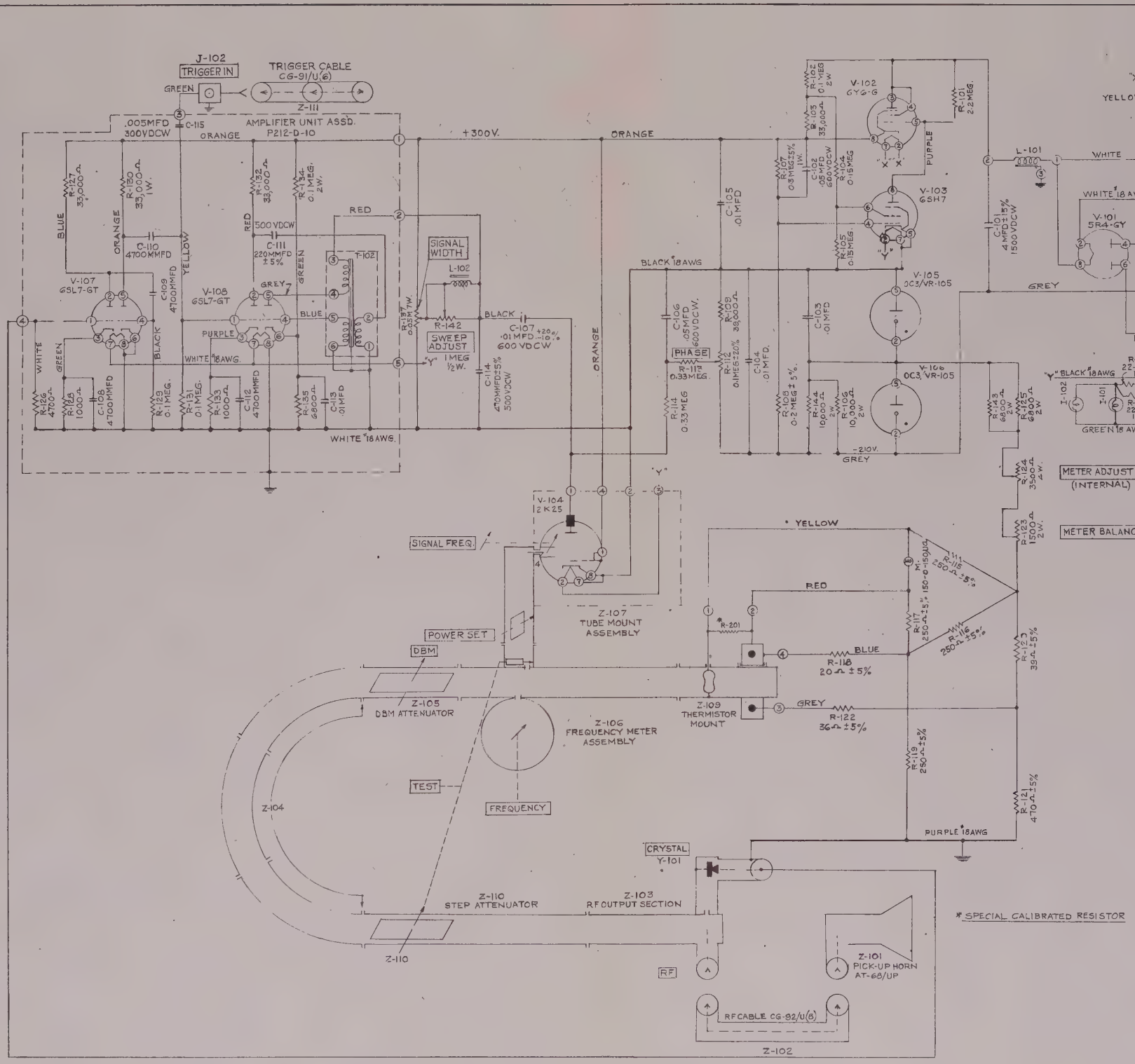


Figure 7-1. Test Set TS-147A/UP Schematic Diagram

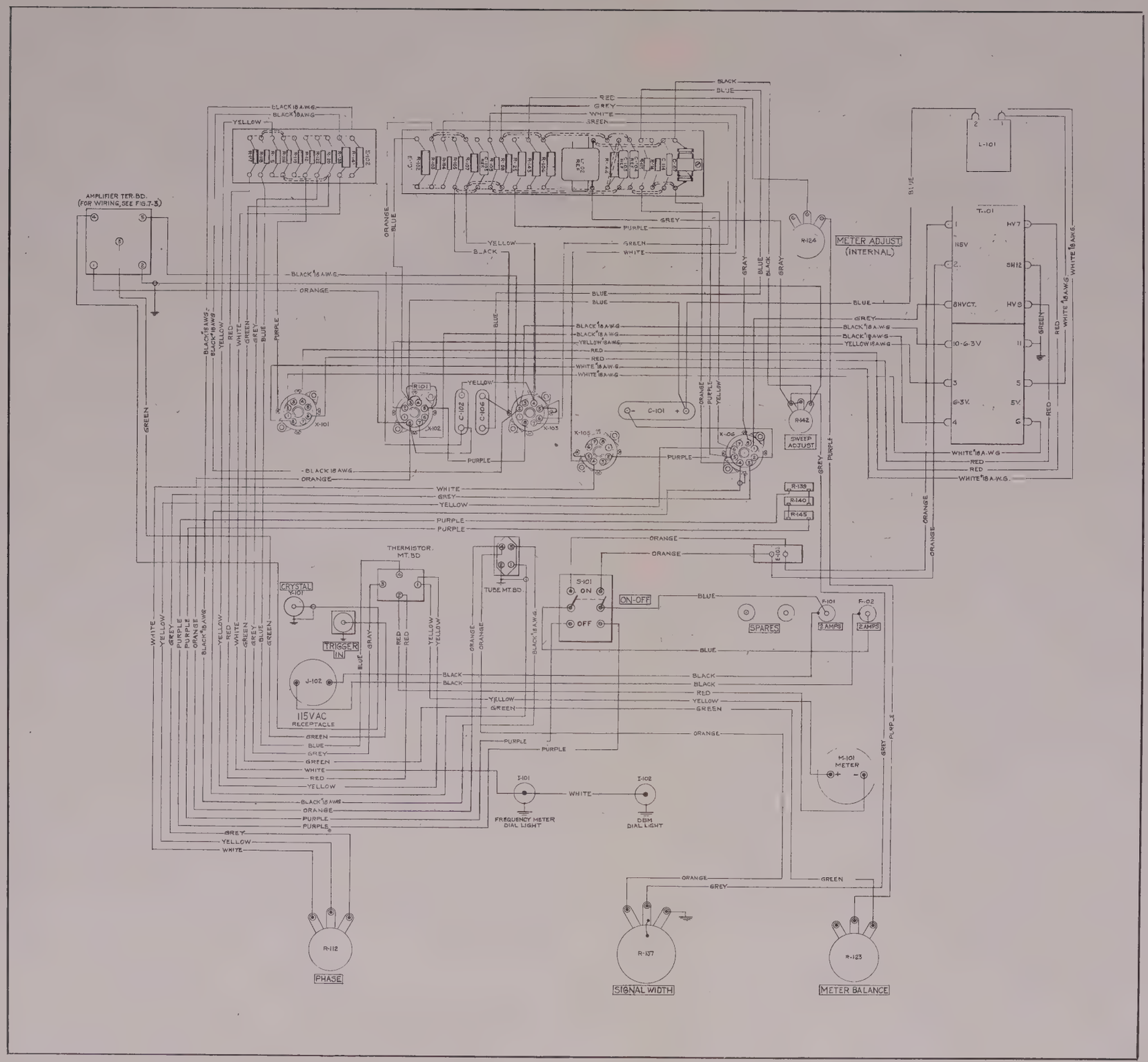
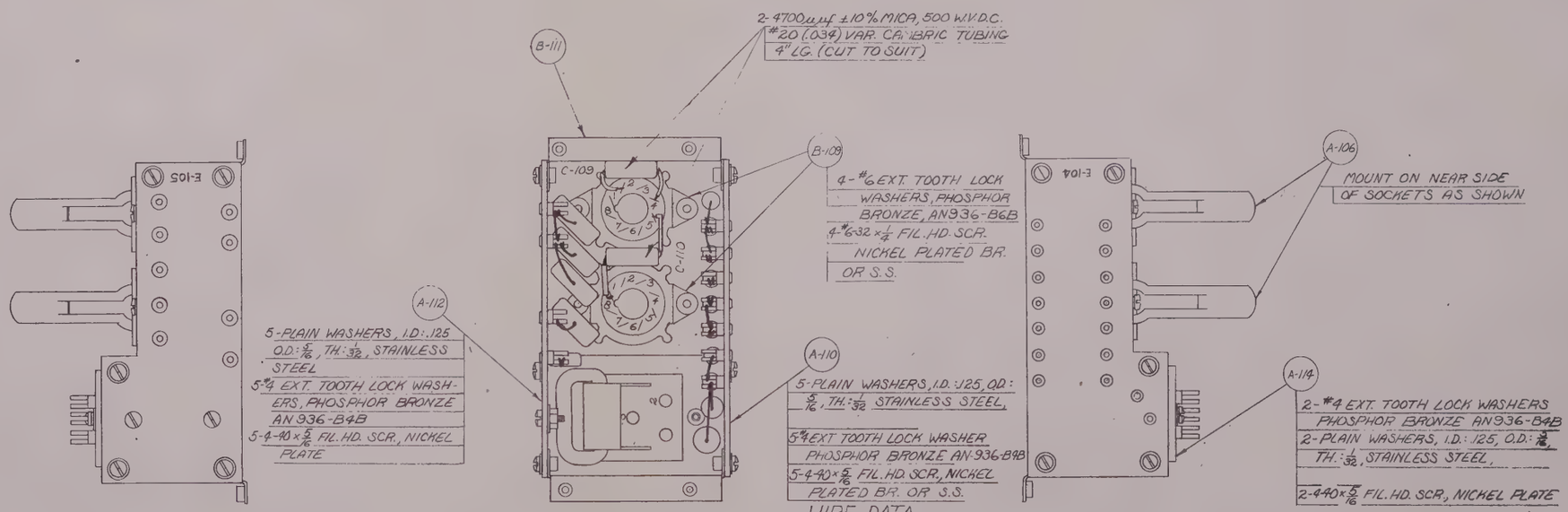
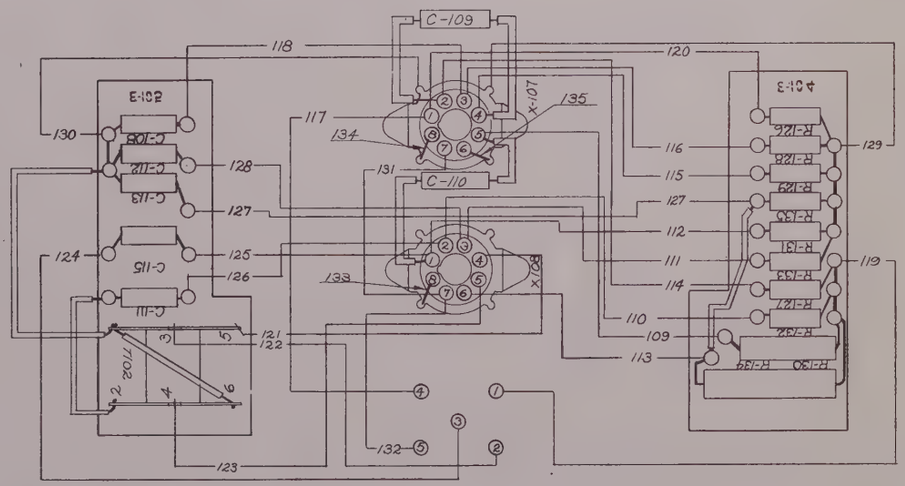


Figure 7-2. Power Supply Chassis and Control Panel Wiring Diagram


2-4700 μμf ±10% MICA, 500 W.V.D.C.
#20 (.034) VAR. CAMBRIC TUBING 4" LG. (CUT TO SUIT)
B-111
B-109
4-#6 EXT. TOOTH LOCK WASHERS, PHOSPHOR BRONZE, AN936-B6B
4-#6-32 x 1/4 FIL. HD. SCR. NICKEL PLATED BR. OR S.S.
A-106
MOUNT ON NEAR SIDE OF SOCKETS AS SHOWN
A-112
5-PLAIN WASHERS, I.D.: .125 O.D.: 5/16, TH.: 1/32, STAINLESS STEEL
5-#4 EXT. TOOTH LOCK WASHERS, PHOSPHOR BRONZE AN936-B4B
5-4-40 x 5/16 FIL. HD. SCR., NICKEL PLATE
A-110
5-PLAIN WASHERS, I.D. .125, O.D.: 5/16, TH.: 1/32 STAINLESS STEEL,
5-#4 EXT TOOTH LOCK WASHER PHOSPHOR BRONZE AN936-B4B
5-4-40 x 5/16 FIL. HD. SCR, NICKEL PLATED BR. OR S.S.
A-114
2-#4 EXT. TOOTH LOCK WASHERS PHOSPHOR BRONZE AN936-B4B
2-PLAIN WASHERS, I.D.: .125, O.D.: 5/16, TH.: 1/32, STAINLESS STEEL,
2-4-40 x 5/16 FIL. HD. SCR., NICKEL PLATE
E-105
E-104
C-109
C-110

WIRE DATA

RUN#	FROM: TERMINATION	TO:	COLOR	LENGTH	SPECIFICATIONS
109	R-130	X-107-5	ORANGE	5 1/4"	
110	R-132	X-108-2 (B)	RED	4 3/8"	
111	R-133	X-108-3	VIOLET	3 5/8	
112	R-131	X-108-1 (A)	YELLOW	4	
113	R-134	X-108-6	GREEN	3 7/8	
114	R-127	X-107-2	BLUE	5 5/8	
115	R-129	X-107-4	BLACK	5 3/8	
116	R-128	X-107-3	GREEN	3 1/2	
117	X-107-1	TERMINAL #4	WHITE	5 1/2	
118	C-108	X-107-3	GREEN	3 1/4	
119	* (C)	TERMINAL #1	ORANGE	5 5/8	#20 AWG
120	R-126	X-107-1	WHITE	3 3/4	
121	T-102-5	X-108-4	BLUE	3 3/8	
122	T-102-3	TERMINAL #2	RED	3 5/8	
123	T-102-4	X-108-5	GREY	4 1/8	
124	C-115	TERMINAL #3	YELLOW	5 5/8	
125	C-115	X-108-1	YELLOW	3 1/8	
126	C-111	X-108-2	RED	3 1/4	
127	C-113	R-135	GREEN	4 1/8	
128	C-112	X-108-3	VIOLET	3 1/8	
129	**	GROUND	WHITE	4	
130	C-108, C-112, C-113	GROUND	WHITE	3 3/4	#18 AWG
131	X-107-7	X-108-7	WHITE	3 5/8	
132	X-108-7	TERMINAL #5	WHITE	4 1/8	
133	X-108-8	GROUND	BUS		
134	X-107-8	GROUND	BUS		#20 AWG
135	X-107-6	GROUND	BUS		



WIRING DIAGRAM

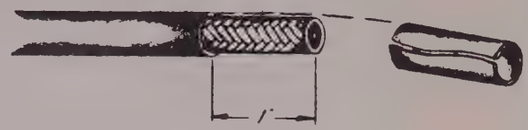
FINISH: MOISTURE AND FUNGUS RESISTANT TREATMENT WITH FLUORESCENT DYE ALL OVER EXCEPT CONTACTS ON TUBE SOCKETS & TERMINALS ON TERMINAL BLOCK

* R-127, R-130, R-132, R-134

** R-126, R-128, R-129, R-131, R-133, R-135

Figure 7-3. Amplifier Unit Wiring Diagram

1. CUT OUTER JACKET SQUARE & EVEN BACK 1". BE CAREFUL NOT TO NICK OR CUT BRAID WIRES.



2. PUSH BACK BRAID & CUT OFF 1/4 OF CABLE DIELECTRIC.

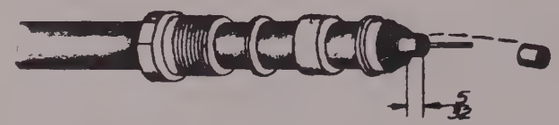
3. PULL BRAID FORWARD & TAPER TOWARDS CENTER CONDUCTOR.

4. THEN SLIDE ON NUT, WASHER, GASKET & CLAMP IN THAT ORDER.

5. BE SURE CLAMP CLEARS ALL BRAID WIRES & ITS INTERNAL SHOULDER RESTS SQUARELY AGAINST END OF OUTER JACKET.

6. UNBRAID SHIELD WIRES, SPREAD OPEN & LAY BACK ON CLAMP WITHOUT WIRES CROSSING EACH OTHER. CUT OFF EXCESS BRAID WIRE LENGTH SO THAT EACH WIRE WILL END BEFORE TOUCHING SHOULDER OF CLAMP.

7. CUT OFF CABLE DIELECTRIC 5/32 FROM END OF BRAID WIRES. BE SURE TO CUT SQUARE & EVEN & DO NOT NICK CENTER CONDUCTOR.



8. CUT CENTER CONDUCTOR 3/16 FROM END OF CABLE DIELECTRIC & TIN.

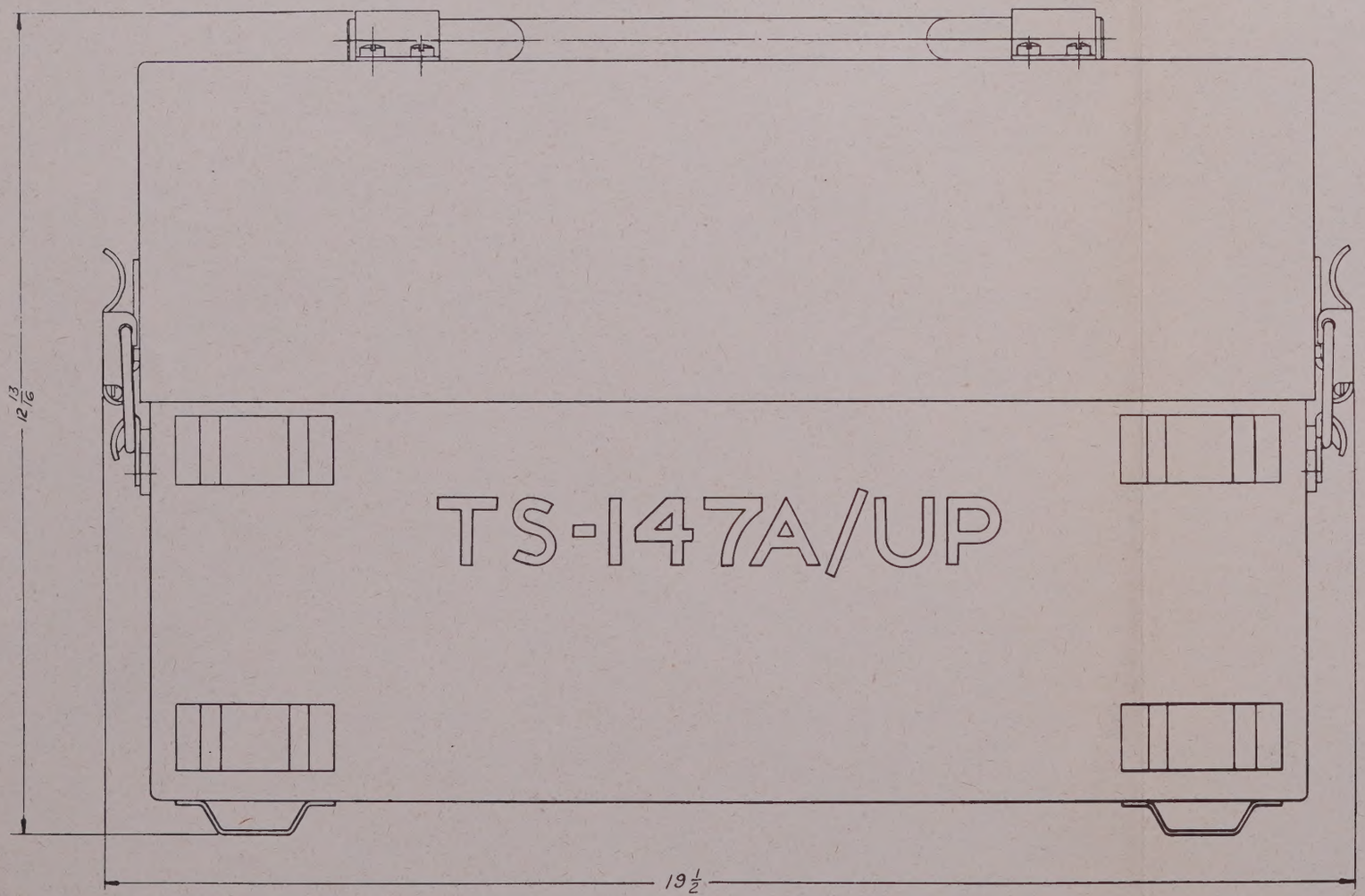
9. SOLDER MALE CONTACT CAREFULLY & REMOVE EXCESS SOLDER. BE CAREFUL THAT SOLDER OR FLUX DOES NOT GET ON END OF CABLE DIELECTRIC.

10. BRING NUT & PLUG BODY TOGETHER AS SHOWN TO ENGAGE THREADS.

11. INSERT CABLE INTO PLUG BODY AS FAR AS IT WILL GO. PUSH GASKET & WASHER INTO BODY & TIGHTEN NUT. HOLD BODY WITH WRENCH & TIGHTEN NUT. DO NOT ALLOW BODY OR CABLE TO ROTATE DURING THIS OPERATION.

Figure 7-4. Cord CG-92B/U (8) Fabrication Notes

T. O. No. 16-35TS147-11



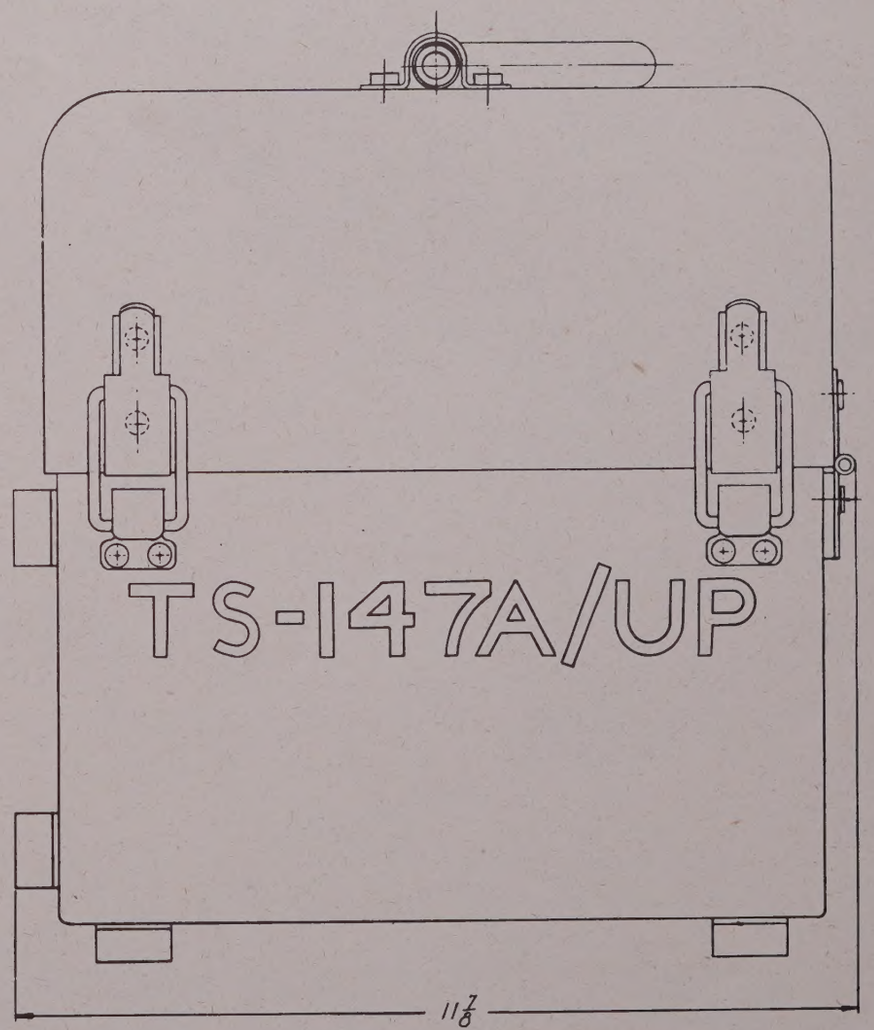


Figure 7-5. Test Set TS-147A/UP Outline

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